MACHINE DESIGN

PARTS • MATERIALS • METHODS • FINISHES

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

Volume 8 FEBRUARY, 1936 Number 2

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Published Monthly at
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Cleveland, Ohio

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MACHINE DESIGN is published on the tenth of each month. Subscription rates: United States and possessions, Cuba and Mexico, two years $5; one year $3. Single copies 35 cents. Canada, one year $4.80, including duty. Great Britain and other European countries, two years £1.13.6; one year £1.00.

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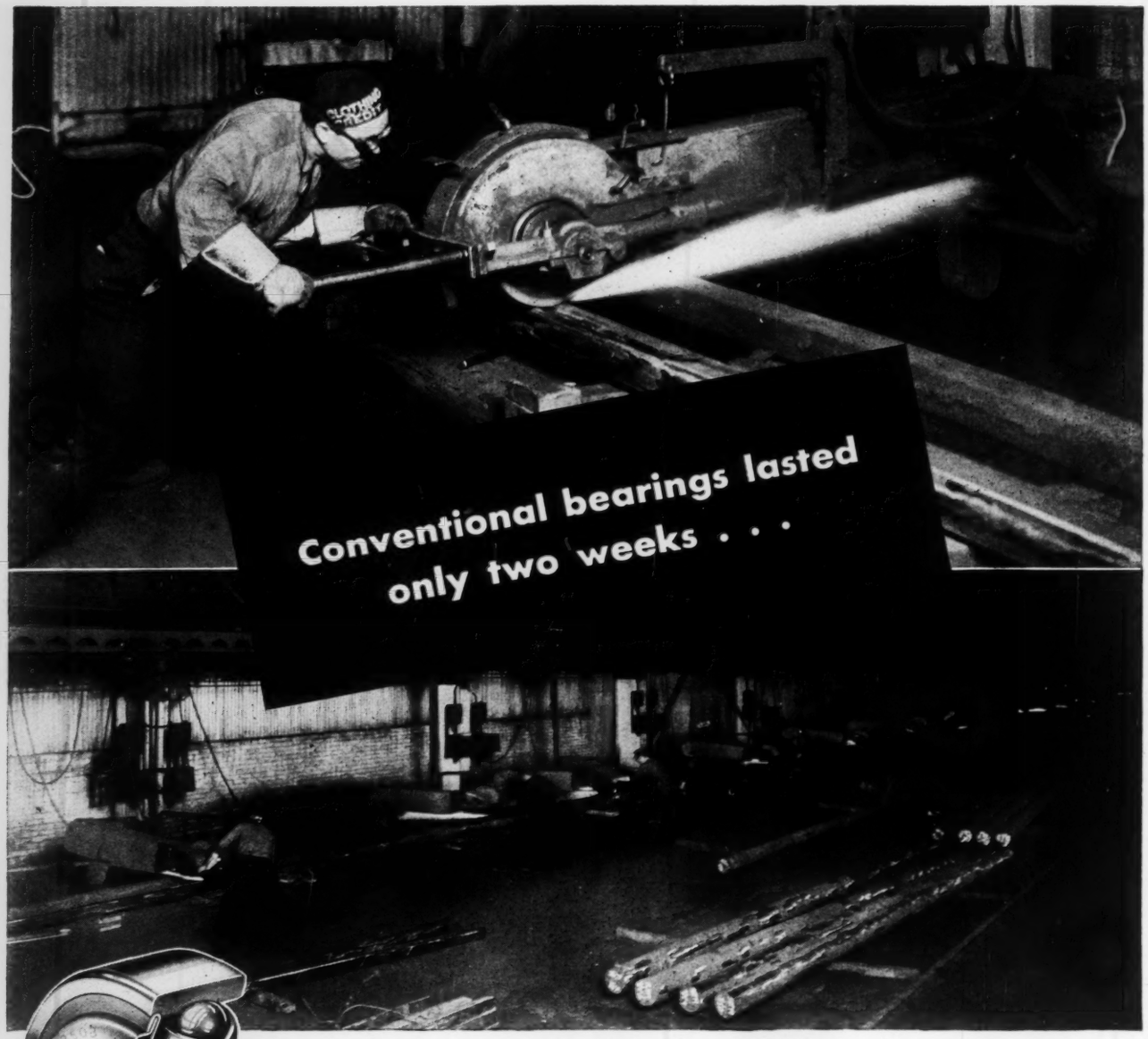
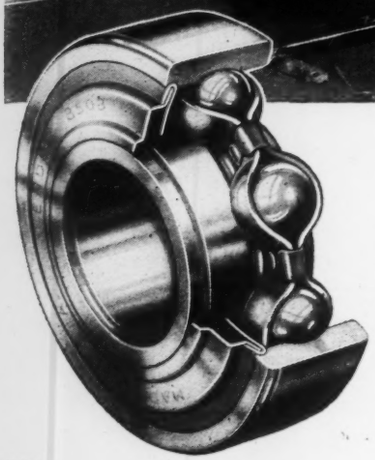
Acceptance under act of June 5, 1934, authorized July 20, 1934.





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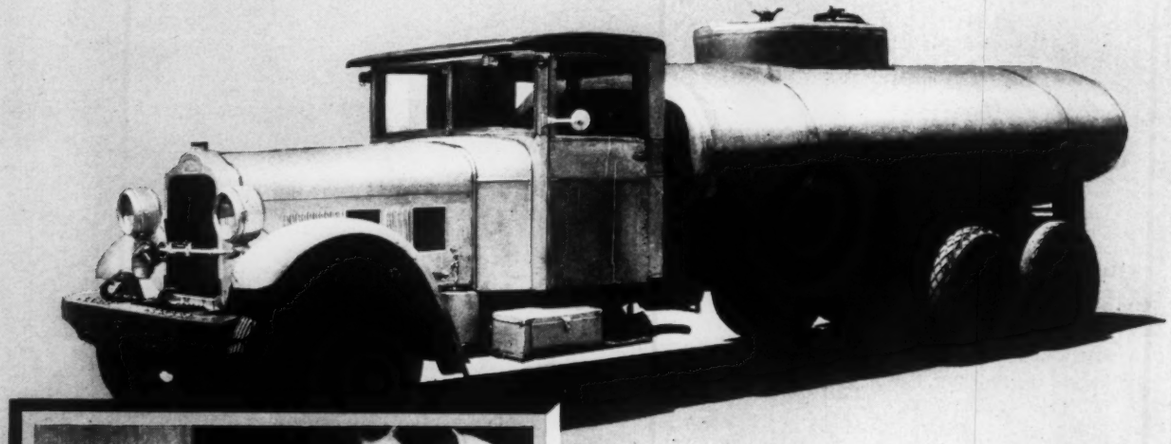
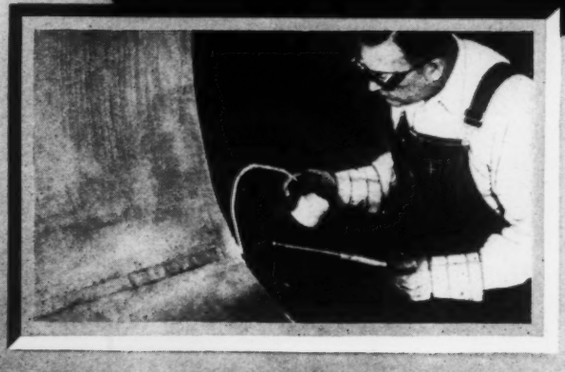




MACHINE DESIGN

Easing the Designer's Load in Selection of Springs

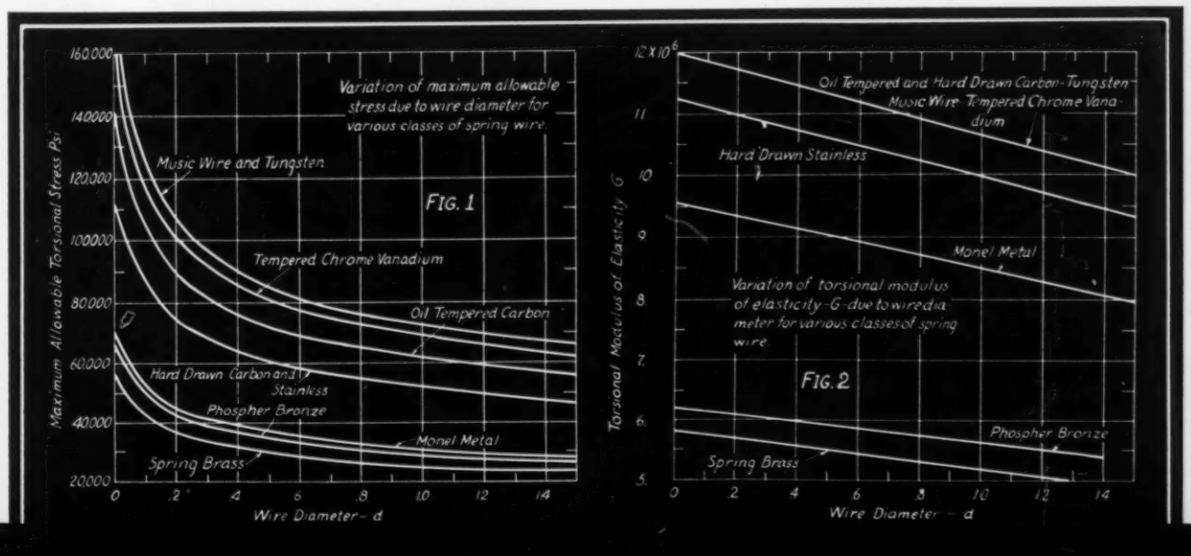
By Harold W. Whiting
Skinner Engine Co.

A DEFINITE stress figure to be used in spring calculations is important to those designing and using springs. Since the strength of the wire changes with size, it is only reasonable that the spring made from fine wire with a high tensile strength is relatively as good a design as a spring made from large wire with a much lower tensile strength.

Technical publications including MACHINE DESIGN have published from time to time various helical spring charts, all of which gave only approximate results due to the fact that only one value of stress, torsional modulus of elasticity, and class of material was used. Very few of the charts even included the curvature factor, and none took into consideration the changes in stress and elasticity at elevated temperatures. Maximum stresses advisable due to the class of service were also not included. Many of the published charts had too small a range of wire and coil diameters.

The chart submitted by the writer, *Fig.* 3, is based on stresses for carbon steel wire as a base of from 135,000 pounds per square inch torsional stress and 12,000,000 pounds per square inch torsional modulus of elasticity for 0.010-inch diameter wire to 55,000 psi stress and 10,000 psi torsional modulus of elasticity for 1½-inch diameter wire. Pitch diameters range from ⅛ to 8 inches. The factors for curvature correction and class of service are also included. Nine different grades of materials are listed giving correction factors both for the materials and also for the operating temperature. Factors are included to cover extension as well as square wire springs.

When a helical spring is subjected to com-



pression, or extension, the principle stress in the wire is due to torsional shear and when the torsional elastic limit of the wire in a helical spring is exceeded by extension or compression of the spring, its length may be permanently increased or decreased. A series of static load tests on springs made from tempered wire showed that setting occurred at a torsional stress approximately 45 per cent of the tensile strength of the wire. The spring chart of *Fig.* 3 is therefore based on oil-tempered wire with the maximum allowable torsional stresses derived from the following formula:

$$S = 0.45\left[\frac{138{,}000}{\sqrt[4]{d}} - \frac{1600}{d}\right] \quad \ldots\ldots (1)$$

The stresses allowable for different wire materials from 0.010 to 1½ inches diameter are:

	0.10 inch to 1½ inches dia.		Relative Stress
Oil tempered carbon steel	135,000	55,000	1.0
Hard drawn carbon and stainless	112,500	46,000	0.83
Tungsten and music wire	160,000	65,000	1.18
Tempered chrome-vanadium	151,000	62,000	1.12
Monel metal	67,500	27,500	0.50
Phosphor bronze	64,000	26,200	0.47
Spring brass	54,000	22,000	0.40

Curves in *Fig.* 1 were plotted using the foregoing formula with the various relative factors.

Studies Modulus of Rigidity

As the deflection of helical springs is inversely proportional to the torsional modulus of elasticity, G, or the modulus of rigidity as the term is sometimes called, it is necessary to use correct values for G if a correct value of deflection is desired. The modulus of elasticity E bears a definite relation to the torsional modulus of elasticity, G, according to the theory of elasticity. The relation is $G = E/2(1 + \mu)$ where μ = Poisson's ratio. Taking Poisson's ratio equal to 0.3 we have $G = E/2.6$. The author has found from available data and tests made that the torsional modulus G varies according to the class of material and the wire diameter. Because of this varying value of G, due to the wire diameter, in compiling the spring chart the following formula was assumed:

$$G = \frac{4}{3} \times (9\text{-}d)10^6 \quad \ldots\ldots (2)$$

On this assumption the factors for G for different wire materials from 0.010 to 1½ inches diameter are as follows:

	0.010 inch to 1½ inches dia.		Relative Elasticity
Oil temp. and hard drawn carbon	12×10^6	10×10^6	1.0
Tempered chrome-vanadium and music wire	12×	10×	1.0
Hard drawn stainless	11.3×	9.4×	0.94
Monel metal	9.6×	8.0×	0.80
Phosphor bronze	6.4×	5.3×	0.53
Spring brass	5.9×	4.9×	0.49

The curves in *Fig.* 2 were plotted using the above formula with the various relative G factors.

Elasticity at Elevated Temperatures

The settage of a spring when operated at temperatures above normal is a separate problem compared with the effect of heating a spring before compressing with subsequent operation at normal temperatures. A spring with set completely removed at normal temperatures will show a marked decrease in strength with increase in temperature if loaded and subjected to heat at the same time. At 500-550 degrees Fahr., for instance, an ordinary carbon steel spring when fully compressed will lose a major part of its strength. It is interesting to note that tempered wire springs which have been finished at 800 degrees Fahr. will set under the foregoing conditions in almost exactly the same manner as hard drawn wire springs, indicating that resistance to settage of springs under combined external stress and elevated temperatures is almost entirely dependent upon chemical analysis, regardless of the method of processing of either the wire or springs. It is difficult to make accurate estimates of settage since a marked creep or progressive settage is noted with increased time at any given temperature.

In the development of springs to operate at elevated temperatures, tungsten, stainless and heat resisting alloys have many applications since they retain a greater degree of strength compared with carbon steel wires. Monel metal has been used for such springs successfully only where the material has been stressed through a low stress range, its particular application be-

P and G Multiplication Factors

"P" Factor				Material	"G" Factor			
70°F	300°	550°	800°		70°F	300°	550°	800°
1.0	1.4	3.0	-	Oil temp'd carbon	1.0	.98	.95	-
1.2	1.6	3.6	-	Hard drwn. "	1.0	.98	.95	-
.85	1.1	1.9	-	Music wire	1.0	.98	.95	-
.89	1.0	1.3	2.3	Temp.Chr.Vanad'm	1.0	.99	.96	.90
.85	.90	1.1	1.5	Tungsten	1.0	.99	.96	.90
1.2	1.3	1.4	1.8	Hard dwn.Stainl's	.94	.93	.90	.82
2.0	2.1	2.5	-	Monel metal	.80	.78	.75	-
2.1	3.0	-	-	Phospher bronze	.53	.50	-	-
2.5	3.9	-	-	Spring brass	.48	.44	-	-

Class of Service: 1. Engine valves, 1.5P; 2. Governors etc, 1.25P; 3. Pop valves " , 1.0P

Sq. wire, .95P & 1.43G. Extension springs, use 1.25P.

Formulae: $P(\text{safe load}) = \frac{S\pi d^3}{8kD}$

where $S = .45\left[\frac{138000}{\sqrt[4]{d}} - \right.$ …

$k = \left[\frac{4c-1}{4c-4} + \frac{.61}{c}\right.$ …

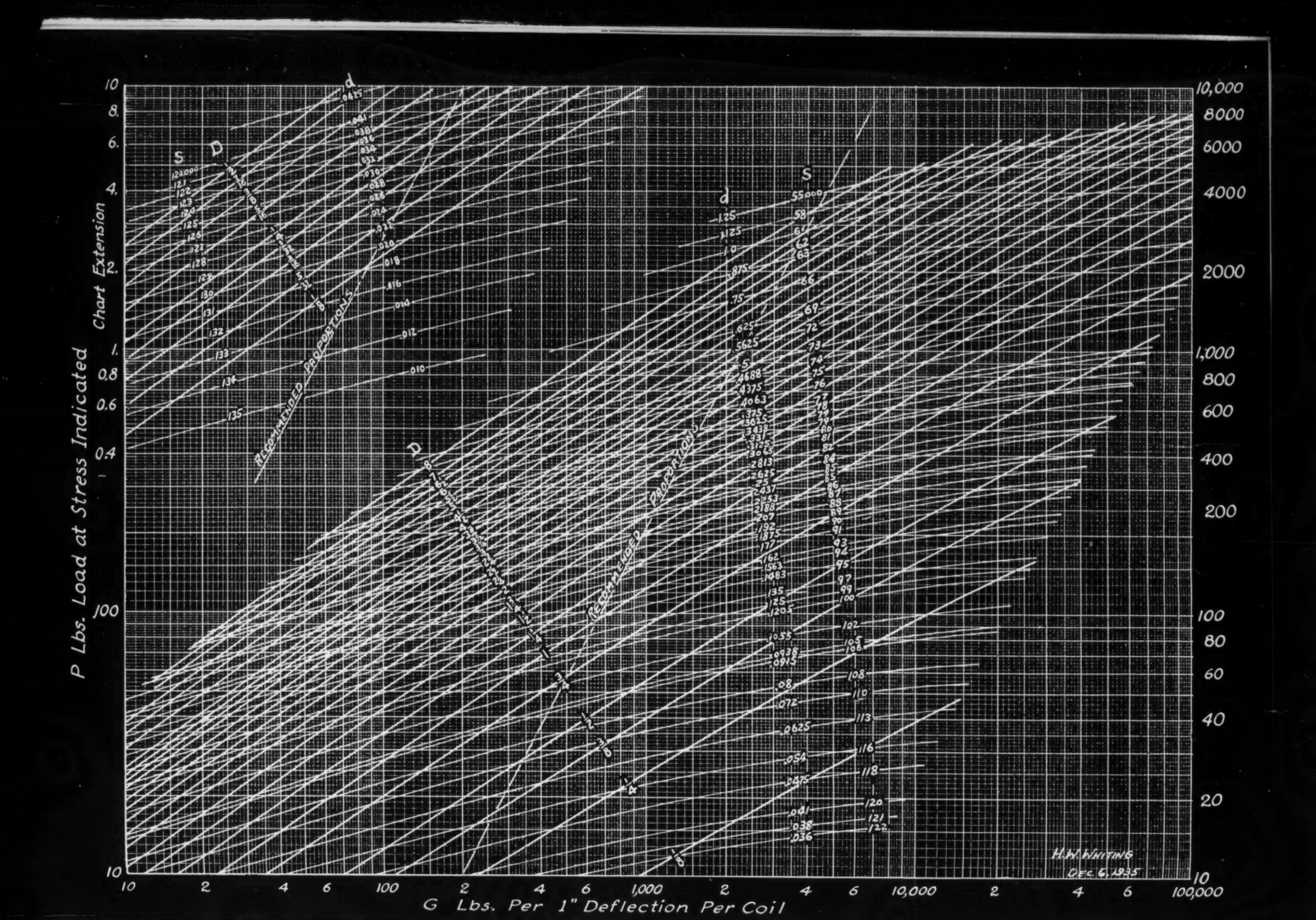
$c = D/d$

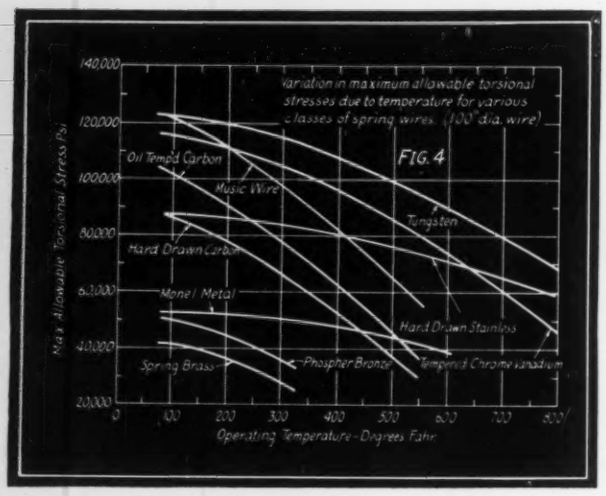
Lbs/1"deflect'n $= \frac{Gd^4}{8ND^3}$

where $G = \frac{4}{3}(9-d)10^6$

d-wire dia. D-Pitch …

Fig. 3—*Chart for the design of helical spr… includes complete range of stresses and p… diameters, factors for curvature correction … class of service, and ten different grades … materials*


P Lbs. Load at Stress Indicated
Chart Extension
G Lbs. Per 1" Deflection Per Coil
RECOMMENDED PROPORTIONS
RECOMMENDED PROPORTIONS
H.M. WHITING
DEC. 6, 1935



ing where it must meet a combination of corrosion and heat or heat alone.

Neither Monel metal nor phosphor bronze can be used in valve springs or such parts that are subjected to elevated temperature without radical redesign requiring the use of large springs. Its use for this purpose is not considered economical because of its greater cost than steel. On the other hand, there are applications where Monel metal performs satisfactorily at temperaures up to and including 600 degrees Fahr. 18 per cent chromium-8 per cent nickel stainless may be used through a similar range. However, phosphor bronze rapidly loses its elasticity above 250 degrees Fahr. The endurance limit of the 18-8 alloy is reduced about one-third when operating at a temperature of 300 degrees Fahr. The endurance limit of phosphor bronze is also lowered with temperature exceeding 200 degrees Fahr. To sum up then, it may be said that phospher bronze because of its uniformity in properties, its mild heat resistance, and its corrosion resistance seems superior to Monel metal and the 18-8 alloy for general spring purposes at ordinary temperatures. Further developments in stainless steel, Monel metal or other alloys may change the situation.

Fig. 4 shows the effect of heat on the torsional strength of various grades of wire while *Fig.* 5 shows the change in the elastic properties of various wires due to elevated temperatures. These curves were plotted from data taken from numerous experiments by various authorities on the subject.

Class of Service

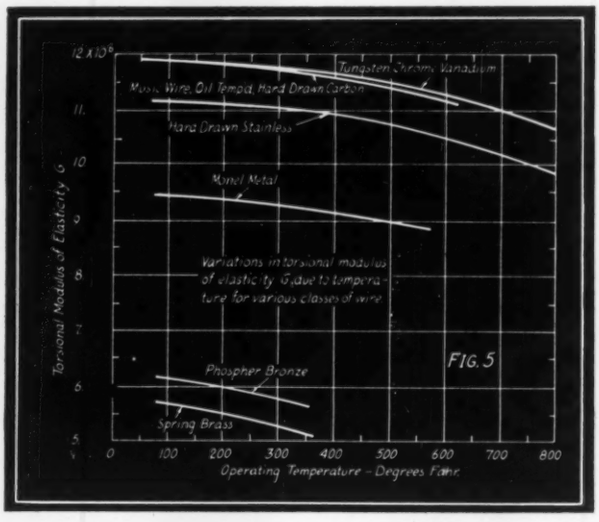
The allowable torsional stress in springs must also be varied to suit the class of service under which they are operated.

CLASS 1. Springs under rapid and regular deflection cycles where the stress range per cycle may be uniform from zero to maximum or intermediate to maximum. Such service being that as in engine valves, plungers etc. The maximum stress to be not more than two-thirds that allowed on the spring chart.

CLASS 2. Springs under rapid and irregular deflection cycles where the stress range per cycle may be variable, from zero to intermediate, intermediate to maximum, or zero to maximum. Such service as is met in governors, car springs, etc. The maximum stress to be not more than 80 per cent of that allowed on the spring chart of *Fig.* 3 or class 3 service.

CLASS 3. Springs under infrequent and irregular deflection cycles where the stress range per cycle follows that for class 2 springs. This class of service includes relief valves and numerous other applications where the spring is under a static load. *Fig.* 3 is based on the stresses for this class of service.

There are two sets of diagonal lines on *Fig.* 3. One set, at an angle of approximately 10 degrees with the horizontal, shows the wire diameter from 0.010 to 1½ inches diameter. Also on these same lines are marked the maximum allowable torsional stresses for each particular size of carbon steel wire and under class 3 service. These stresses were figured from formula (1) described previously. The other set of diagonal lines, at somewhat steeper slope, approximately 30 degrees, gives pitch diameter of the



coil. The range is from ⅛ to 8 inches pitch diameter. Crossing these lines is a single heavy line at about a 60 degree slope labelled "Recommended Proportions." This line corresponds to a ratio of 7 to 1 between pitch diameter and wire diameter, a ratio which is by no means compulsory but which has been found to give good results for general purposes. An extension of the main chart of *Fig.* 3 is found in the upper left hand corner. The horizontal lines give the safe load in pounds at stresses indicated. The formula for the safe load, P is

$$\frac{S\pi d^3}{8kD} \quad \text{.....(3)}$$

where S equals maximum allowable stress corrected for wire diameter, formula (1),

d = wire dia., inches
D = pitch dia., inches

$$k = \text{curvature correction factor} = \left[\frac{4c-1}{4c-4} + \frac{0.615}{c}\right]$$

$c = D/d$

A. M. Wahl very ably describes this factor in "General Considerations in Designing Mechanical Springs" May to August 1930, MACHINE DESIGN.

The vertical lines on *Fig.* 3 give the pounds per inch deflection of a single coil which equals $Gd^4/8D^3$ where G is taken from formula (2).

Gives Typical Examples

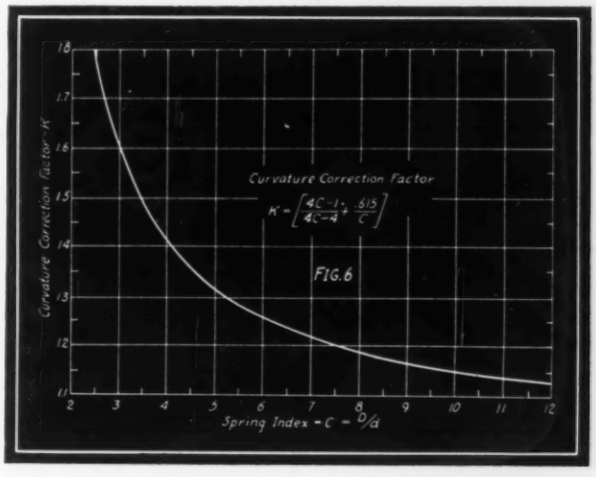
Example 1. A carbon steel spring for class 3 service that will stand a load of 1000 pounds under a deflection of 2 inches. Starting at 1000 pounds at the extreme left of *Fig.* 3 proceed horizontally. All pitch diameters and wire diameters, combinations that intersect each other and cross on this horizontal 1000-pound line will stand a load of 1000 pounds. For instance, coils 5½ inches D with 0.625-inch wire, 4 inches D with 0.5625 wire, 2-13/16 inches D with ½-inch wire, etc., will all stand 1000 pounds load. However, the recommended proportions are 4 inches P.D. with ⅝-inch wire. At this intersection drop vertically reading 2130 pounds per inch deflection per single coil. As 1000 pounds is wanted for a 2-inch deflection, 1000 pounds per 2 inches equals 500 pounds per inch deflection. Dividing, 2130 pounds by 500 pounds equals 4¼ active coils.

Example 2. Assuming the same loadings are wanted in a governor spring under class 2 service. In the tabulation on page 20 will be found for class 2, a P factor of 1.25. Our original 1000 pounds wanted times 1.25 equals 1250 pounds. Starting at the left of *Fig.* 3, proceeding horizontally on the 1250 pound line to a D of 4⅜ inches and 0.625 inch wire, drop vertically to 2550 pounds. This value divided by the 500 pounds per inch deflection wanted equals 5.1 active coils.

Example 3. A tungsten wire spring is desired for valve operation at a temperature of 550 degrees Fahr., in an engine with a maximum loading of 100 pounds and a minimum loading of 75 pounds through ¼-inch deflection or valve lift. The tabulation shows for this service, material and temperature P multiplying factors of 1.5 and 1.2 respectively. Then the maximum loading, 100 pounds × 1.5 × 1.2 = 180 pounds. Starting at this value at the left of *Fig.* 3, proceeding horizontally to 1⅜ inch P. D. and 0.207 inch wire. Dropping vertically, read 1000 pounds. Again referring to the tabulation we find for this material and temperature a G factor of 0.95, and this multiplied by the 1000 pounds equals 950 pounds, the corrected value. As there is a difference of 25 pounds from maximum to minimum loadings (100 pounds—75 pounds) for ¼-inch movement, the loading per inch is 100 pounds. Then 950 pounds divided by 100 pounds equals 9½ active coils.

Discusses Extension Springs

The same principles apply to an extension spring as to a compression spring with one exception. The initial tension which is obtained between adjacent coils may be as high as 25 per cent of the safe load. In other words, in order to open the coils, one-quarter of the safe load of the spring must be applied and only three-quarters of the safe stress is then available for deflection without permanent set. In practical applications, if the extension spring has hooks or loops made by turning up a coil, it has been found that this type of spring usually breaks at the point where the wire is bent to form the loop. Therefore, to design with comparative safety, the safe stress for extension springs should be about 80 per cent of that used for a compression spring under similar circumstances. In the tabulation on page 20 is shown a P factor of 1.25 for extension springs in addition to any other factors to compensate for material, temperature or class of service as outlined for compression springs.



In this tabulation will also be found a P factor of 0.95 and a G factor of 1.43, these factors to be applied when square wire is used in addition to the other factors common to all types of springs.

The author is indebted to the following for the information and data necessary to compile this chart:
"General Considerations in Designing Mechanical Springs," by A. M. Wahl, MACHINE DESIGN, May to August, 1930, issues.
Wallace Barnes Co.
Wickwire Spencer Steel Co.
"Available Data on the Properties of Metals at Various Temperatures," by French, Tucker, Upthegrove and White. *A. S. M. E. Transactions*, 1924.

Scanning the Field . . . FOR IDEAS

DESIGNING FOR ECONOMY

FOUR operating conditions are provided by a new 200-horsepower multispeed fan drive without any actual gear changes. The arrangement, *Fig.* 1, involves the use of two motors of 150 and 50 horsepower capacity, respectively, and a speed reducer. Universal Gear Corp. engineers designed the drive to operate forced draft fans for a utility company when at peak, intermediate or minimum loads. At the low point in current demand it it desirable to operate the draft fans at much slower speeds; in fact four different fan speeds with requirements varying from 50 to 200 horsepower are essential to meet all conditions.

The 150 horsepower motor is equipped with a backstop, while the 50 horsepower reversible motor has a magnetic brake. A multiple V-belt drive connects the larger motor and the speed reducer, driving through a quill shaft. The smaller motor is connected directly to the speed reducer through a line shaft. A system of planetary gearing in which a differential unit plays the important part furnishes a unique speed combination.

When both motors are running in the same direction the unit provides 200 horsepower at the output shaft of the speed reducer. If the 50-horsepower motor is held stationary while the 150-horsepower motor pulls the load, the same output torque is available at an output speed of 750 revolutions per minute. With the 50-horsepower motor running in a direction opposite to that of the 150-horsepower motor, the same output torque is furnished at 500 revolutions per minute. Then as the 150-horsepower motor is held stationary with the 50-horsepower motor running in the same direction as output, the same output torque at 250 revolutions per minute results.

Change from one operating characteristic to

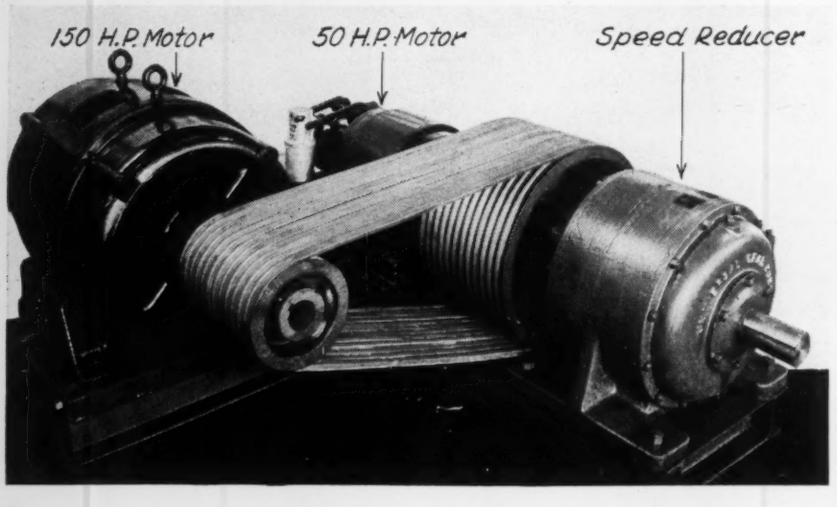


Fig. 1—*Two motors,* 150 *and* 50 *horsepower respectively, are ingeniously coupled with a planetary type reducer to meet changing operating conditions involving loads varying from* 50 *to* 200 *horsepower. Four different speeds are available*

another is accomplished by throwing a switch. The general drive principle is susceptible to almost infinite variations, depending on the motor selections, the intermediate drive to the main speed reduction unit and the step-down ratio of the latter unit.

This type of drive, while new, incorporates no untried principles. At the Universal factory drives of this nature have been in use on machine tools for some time.

BETTER MACHINES—MORE SALES

DESIGN now has progressed to that point where refinement of existing equipment becomes one of the major tasks of the engineer. In other words he is faced with such problems as concentrating controls, building in what had previously been hung on, and improving machines generally to enhance their operation both from the operator's and salesman's point of view. In evolving ideas to meet the requirements of these modern trends he may adopt something like Warner & Swasey's new development, *Fig.* 2, which provides lathes with a single lever control for not only shifting gears but also for actuating the forward and reverse clutch. This innovation also introduces a built-in cutting speed selector and a speed sequence indicator.

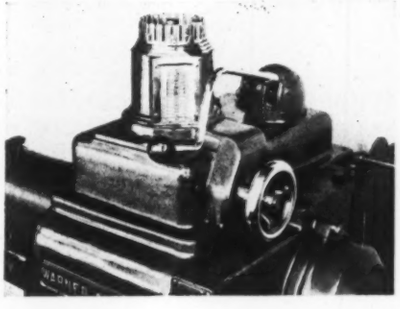


Fig. 2—Cutting speed preselector on this lathe provides single lever control. Moreover, the development, featuring built-in design, embodies a speed sequence indicator

The sequence indicator is in the form of a castellated drum, numerals being inserted in slots to indicate the several speeds required for a particular job. After it has been set up the operator merely rotates a handwheel until No. 1 is in front, after which he pulls a lever and then, while the machine is in operation, brings No. 2 forward. When cut No. 1 is completed he need only actuate the lever to set the machine for cut No. 2. Similarly No. 3 and 4 are consecutively brought forward. Until the device was developed, it was necessary for the operator to remember a series of complicated lever positions for consecutive speed selections on a given job, making it difficult to use more than three or four speeds. With the indicator, as many speeds as can be ideally employed on a job will be used by the operator without hesitation because he need only set the machine from one number to the next for each shift, thus eliminating considerable mental effort.

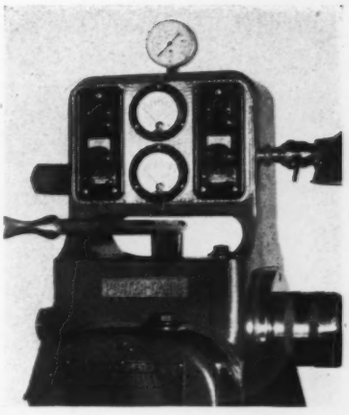


Fig. 3—Another built-in unit is this head which centralizes the entire electrical and hydraulic pressure systems, bringing the controls within easy reach of the operator

Another significant development is the electrical head, *Fig.* 3, employed on Porter-Cable lathes. This unit provides a central control for the entire electrical and pressure systems, bringing them directly before the operator's eyes. The panel embodies the starting and stopping buttons for all motors, pressure gages for either air or hydraulic mechanisms, direct reading ammeters to show the amount of power being consumed and to enable the operator to maintain proper feeds and speeds, thus obtaining maximum efficiency of machine and cutting tools. The electrical head is a boon to the department supervisor; he can check operator and machine at a glance.

IMPROVING THE CAM FOLLOWER

OF THE various mechanical parts that go into the design of a machine few take more punishment than a cam and cam follower. Consequently engineers are obliged to give special attention to these elements, particularly when shock loads are present. It frequently has been found that where speeds must be raised to meet

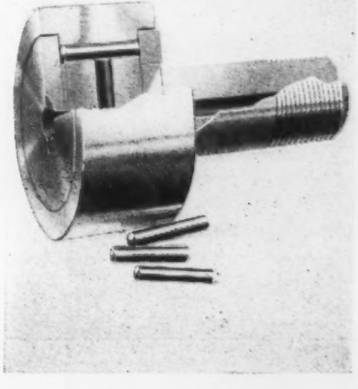


Fig. 4—Advantages of the needle roller bearing are utilized in the design of a new type of cam follower which has a high load capacity

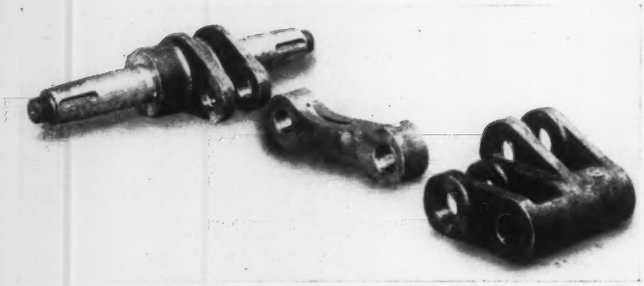


Fig. 5—Use of these three changeable parts adapts a shaker conveyor drive to a variety of speed conditions

production requirements, cam follower bearings of the plain pin type wear excessively or fail entirely. To remedy this condition a cam follower utilizing the advantages of the needle roller bearing, *Fig.* 4, has been developed by McGill Mfg. Co., Valparaiso, Ind.

The new element has high load capacity due to the large areas of contact between rollers and raceways. It is produced as a complete self-contained unit comprising an inner race member, rollers and outer race; as an inner raceway and rollers; outer raceway and rollers; or rollers only are available. The complete assembly is the most desirable because it can be accurately fitted as to radial clearance and initial provision can be made for lubricating.

Such a bearing, in its application, need not be confined to cam follower duty. Many other uses are apparent. It might profitably be employed, for instance, for the elimination of friction in many cases where one machine member reciprocates or has relative motion with relation to adjacent parts.

MAKE MECHANISMS MORE VERSATILE

THREE simple parts, *Fig.* 5, form the nucleus of an idea that has appreciably increased the utility of a Goodman shaker conveyor drive. This type of unit is employed in transporting materials such as coal by kicking forward the trough or pan line by which they are carried. In other words, the drive imparts reciprocating motion to the conveyor trough, causing the coal to progress intermittently forward by the aid of inertia.

The most desirable movement for a device of this type is one that will accelerate the materials to maximum velocity on the forward stroke and commence rapid deceleration of the pan line or trough at the point of maximum forward velocity. It should also quickly accelerate the trough in the opposite direction. Obviously, no one motion can meet all conveying conditions; therefore, to produce the best results consistent with practical design, Goodman engineers have employed the three changeable parts, *Fig.* 5, showing the driving lever to which the pan line is connected, a coupling rod and a bellcrank, to vary the intensity of the "kick." The use of these parts permits the drive to be incorporated in shaker conveyors for handling other types of materials, resulting in a universal feature that virtually every designer at one time or another seeks to attain.

UTILIZING SPIRAL FOR COMPACTNESS

CONTROLLED centrifugal force is substituted for gravitational force in the Podbielniak super-fractionator, *Fig.* 6. Because the fluid passage can be coiled into a spiral representing a length even as great as several hundred feet—high gravity towers ordinarily are employed—the compactness of this design becomes immediately apparent. Use of high centrifugal force permits vapor velocities up to 100 feet or more per second, liquid velocities up to 10 feet or more per second, and therefore large capacities per unit of cross-sectional area of passage.

The more interesting immediate applications of this type of apparatus are the commercial concentration of heavy water from ordinary water, the ultra-fractionation of alcoholic liquid, essential oils, perfume components, etc. into their pure compounds, the multistage solvent extraction of lubricating oils, vacuum distillation of lubricating oils, etc. The pitch and width of the spiral, the clearance and length of the passage, and the speed of rotation all can be varied to meet any requirements for capacity, turbulence, time of contact and intimacy of reaction.

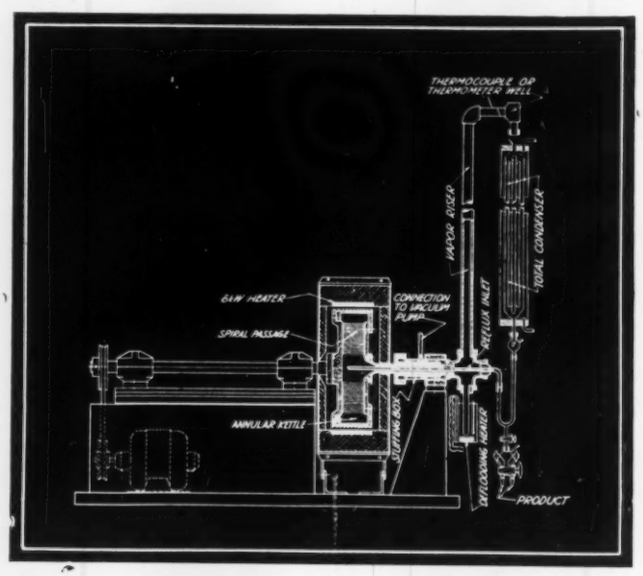


Fig. 6—A coiled passage makes possible high fractionating efficiency in an apparatus of compact design

Hydraulics Finds Ally in Electric Oscillator

By E. C. Brown
Assistant Chief Engineer
Austin-Western Road Machinery Co.

CO-ORDINATION of hydraulic and electric mechanisms is making possible achievements in design that would have seemed impracticable a few years ago. Not only have improved operating characteristics resulted from the combination of these devices, but features such as remote control and one-man supervision now are realities in machinery of the mobile type. A specific example of these accomplishments is found in the Austin-Western scraper, an earth moving machine, *Fig.* 2, that excavates, hauls and spreads the material. Unlike a stationary machine, it is absolutely essential that the unit and its electric and hydraulic equipment be self-contained and as compact as possible.

Before discussing in detail the hydraulic and electric innovations of the machine it is desirable for sake of clarity to cover some of the features of general design. In order to meet the requirements for a strong frame, a one-piece welded unit was built around two heavy Man-Ten rolled steel rails *A*, *Figs.* 3 and 4, arched sideways to accommodate the hopper. Flexibility of the frame was increased by a three-point mounting with a ball and socket connection between the front axle and the inner column of the king post. This post has an outer member or shell which is a built-up square column, welded be-

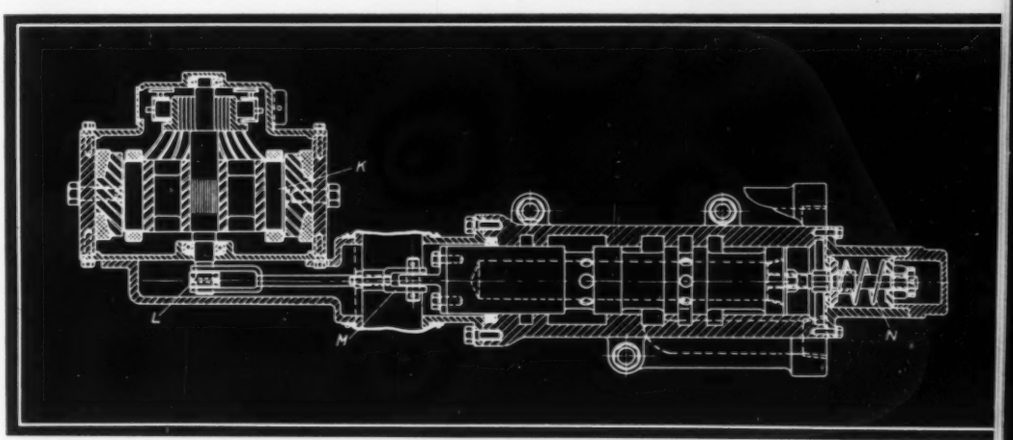
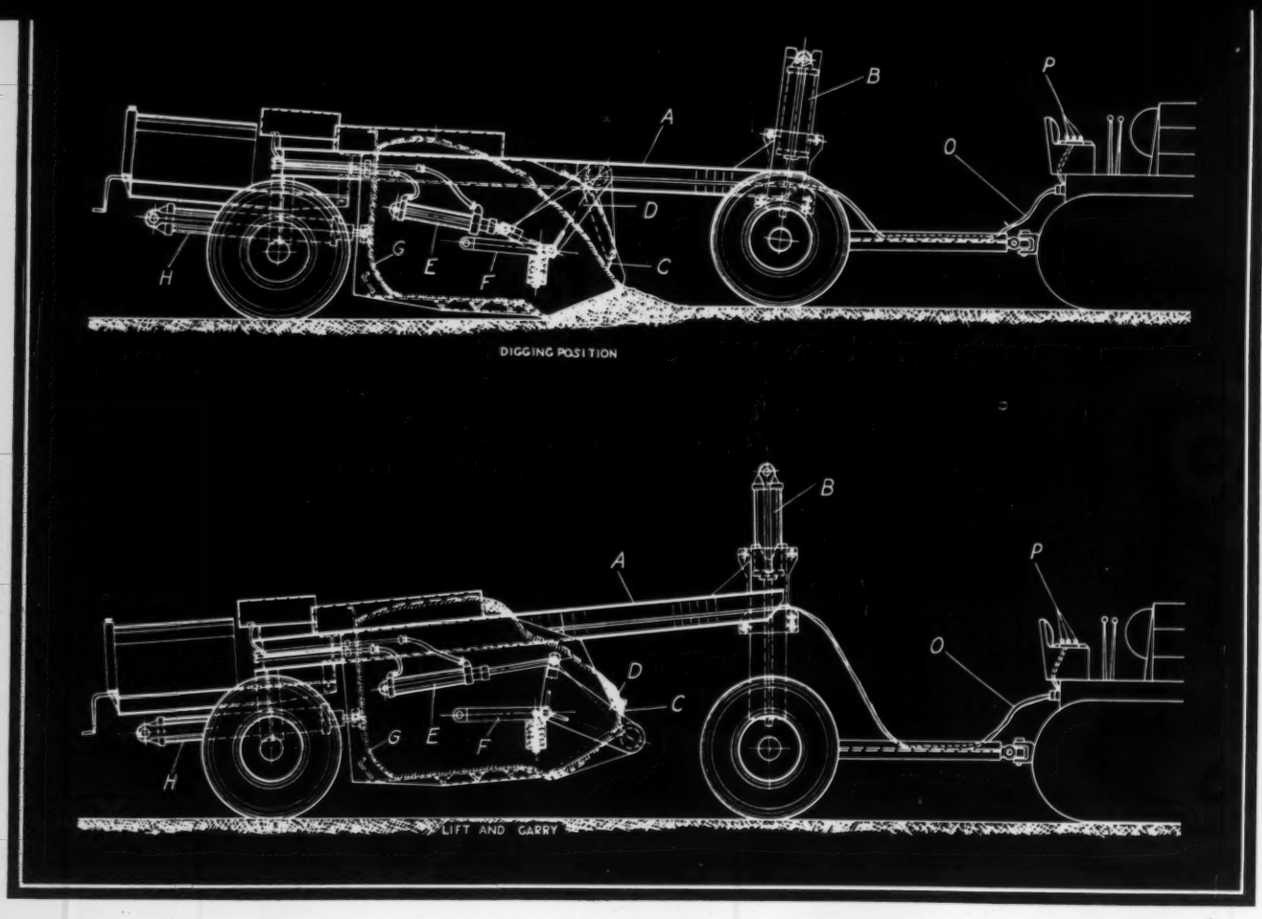


Fig. 1 — *Above* — *Each hydraulic valve is actuated by a magnetic oscillator K controlled by the operator from a remote point*

Fig. 2 — *Right* — *Welded steel construction is utilized throughout scraper*



Figs. 3 and 4—Above—These two operating positions reveal the effectiveness of the hydraulic mechanisms in carrying out the scraper's functions

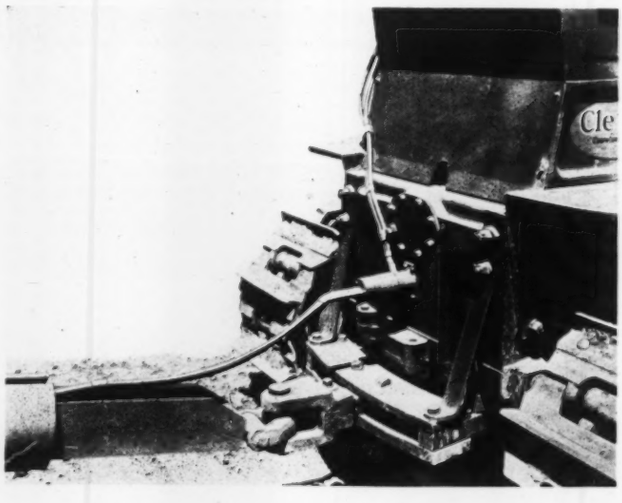
tween the ends of the rails, and slidable upon the inner column. Within the column is mounted an hydraulic cylinder *B* which raises or lowers the frame and hopper in relation to the front axle, thus controlling the digging depth and enabling the loaded hopper to be hoisted during travel of the machine from one point to another.

Welded Construction Employed

The hopper is built of alloy steel plate welded to the side frame members and joined at the bottom by a double-decked floor of built-up plate construction. A floating hinge-type front door *C*, also of welded plate design, is pivoted to the floating side bars *D* and opened and closed by two hydraulic cylinders *E*, one on each side of the hopper to provide equal movement for opening and closing the door. Side hinge bars *F* are spring mounted to permit one or the other end of the door to ride over an obstruction in closing, without undue strain on the door itself. This hinged construction also protects the door against damage should the closed door of the machine encounter an obstacle in the path of the unit while in transit.

To discharge the material loaded into the hopper at a uniform rate of speed, a rear push-out door *G* is employed, positioned vertically across the full length of the hopper. Uniform movement of this door is insured and binding obviated by the use of a large double-acting hydraulic cylinder *H* connected to the center of the door. The two upper corners of the door are mounted on a double trunnion roller arrangement which utilizes the side rails *A* as tracks. A heavy cross shaft mounted in bronze bearings and fastened to the upper rear edge of the door, is carried on two gears that mesh with cast racks welded to the top of each side rail. This prevents one side of the door from traveling ahead of the other, while the trunnion rollers, placed at each outside end of the upper portion

Fig. 5—Below—A slip socket or junction plug serves as the sole electrical connection between the scraper and the tractor, on which the control is located



of the sliding door, maintain the bottom of the door in line with the top. Housings protect the members from dirt.

Hydraulics offered the logical answer in the carrying out of the various operations outlined in the preceding paragraphs, primarily because it furnishes a simple and easy means of control. Layout of the circuit, depicted in *Fig.* 6, incorporates two side cylinders *E* which actuate the front door; the front-raising cylinder *B*; and the rear pushout cylinder *H*. Rotary pump *J* is direct-connected to the gasoline engine at the rear of the scraper, which can be seen in *Figs.* 3 and 4. Oil under pressure passes to the first of the three piston type balanced control valves *X*, *Y* and *Z*, *Fig.* 6. Relief action is obtained by a balanced type relief valve set for 500 pounds per square inch. As shown, the valves are arranged in series; when all three are in neutral the oil bypasses from the pump back to the reservoir under no pressure, thus relieving the pump from working continuously under a pressure head. One or all three valves can be operated either independently or simultaneously without loss of piston speed for any of the parts being controlled.

AMONG the hundreds of machines exhibited at the recent road machinery exposition in Cleveland, the Austin-Western scraper discussed in the accompanying article stood out as one of the most striking examples of engineering. It exemplified the increasing adoption of hydraulics, welded construction using the new low-alloy high-tensile steels, and the trend toward improved appearance, all of which were apparent in the numerous machines on exhibition. In addition to these modern design features, the impressive display represented a new high in the use of diesel engines. Road machinery was at one time the essence of crudity—now it holds a firm place among the most progressive mechanical industries

Control Is Electro-Magnetic Type

It will be seen from the foregoing that use of the tractor power plant to drive the pump would necessitate long sections of hydraulic hose running from the tractor to the scraper besides reducing the pulling power of the tractor. Consequently the entire hydraulic mechanism is mounted adjacent to the gasoline engine of the scraper, which also furnishes power for driving a 24-volt generator, *Fig.* 7. This, however, created a need for a remote control system which has been ingeniously designed to enable the tractor operator to supervise the various functions of the scraper from his seat on the tractor. Also, for simplicity and at the same time to provide a means whereby the scraper can be quickly disconnected, an electro-magnetic type of control was selected. No other arrangement would better meet the requirements of operation from a remote point.

Spring Closes Valve Ports

In employing this idea the engineers were confronted with the development of valves which could be operated by magnetic oscillators *K*, *Figs.* 1 and 6. Each oscillating mechanism is connected to the valve piston through a crankarm indicated at *L* and linkage *M*, *Fig.* 1. A spring *N* acts to close the ports of the valve immediately the current is shut off. Current for

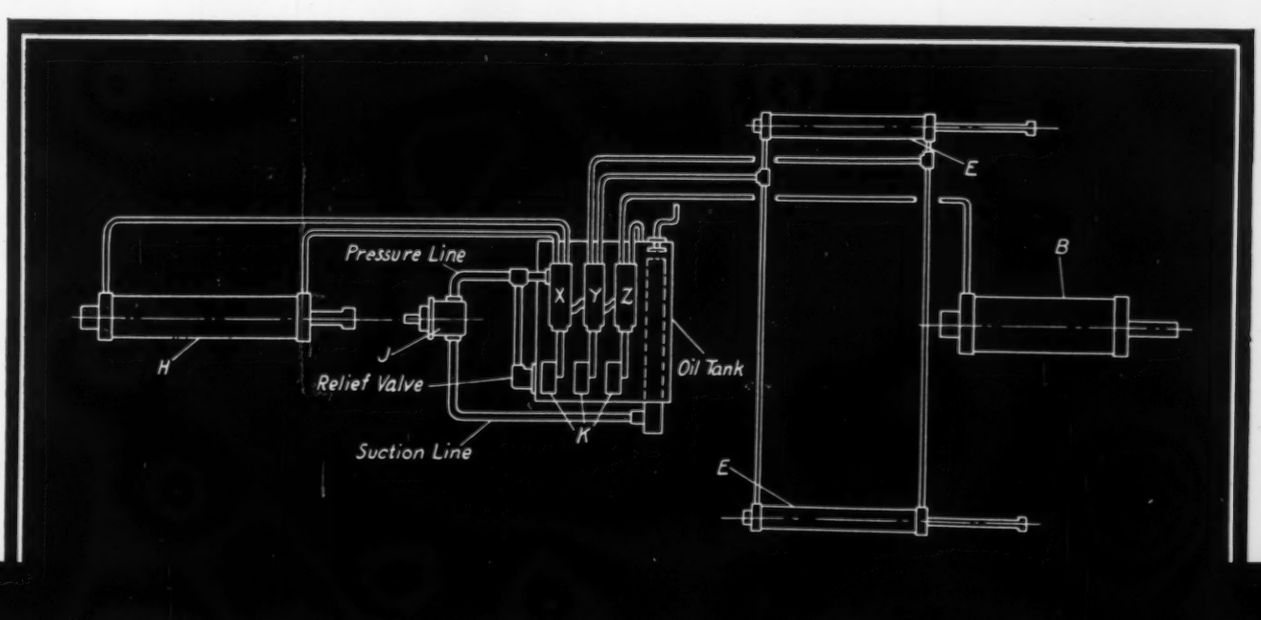


Fig. 6 — *Diagram illustrates relation between valves, pressure lines and cylinders. The latter are of seamless tube as well as of cast construction*

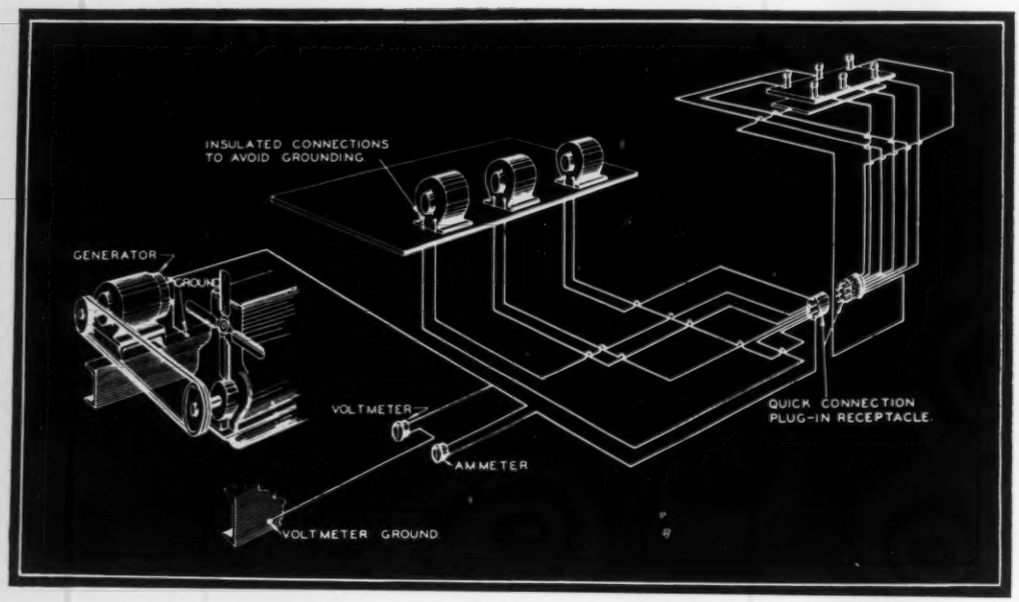


Fig. 7—A 24-volt generator driven by a gasoline engine on the scraper furnishes electric current for the three oscillators that actuate the hydraulic valves. Note the centralized controls at the right

the oscillators is supplied by the direct-current generator.

A seven-wire conductor cable *O, Figs.* 3 and 4, connects the switches *P* by which the operator controls the oscillators. A slip socket or junction plug, *Fig.* 5, is located on the tractor to permit automatic disengagement, a safety feature that is particularly essential should the drawbar pin either fall out or break.

To effect economy by idling the gasoline engine on the scraper during traveling cycles a remote control device embodying a specially designed solenoid is employed. This solenoid, which operates on either six or twenty-four volts and controls the butterfly of the carburetor, can be actuated by the operator from his seat on the tractor to reduce the speed of the scraper engine from 1450 to 600 revolutions per minute.

Cylinders Utilize Seamless Tubes

The large push-out door cylinder located underneath the gasoline engine on the scraper is of seamless tube construction, with welded flanges and cast steel heads. Unloading speed is approximately 10 seconds, with a 40-inch travel, the piston exerting a force of 22,000 pounds on the rear door. The front door cylinders likewise are of seamless steel tube construction, each being capable of exerting a force of 8000 pounds.

The hydraulic cylinder employed to raise and lower the front end of the scraper, is of cast construction and because of its large diameter can lift approximately 27,000 pounds. It permits the operator to raise the front end in approximately eight seconds and lower it in three seconds. The single acting cylinder, with a direct discharge line to the tank, makes possible this faster lowering, a desirable feature in making a new cut into the earth.

There being no obstructions across the top of the pan, the scraper can be loaded by a shovel or elevating grader, but as ordinarily used, it performs its own digging, loading, hauling and dumping operations.

Designers' Responsibilities Increase

Oil pressure lines are of seamless steel tubing throughout and are clamped to the scraper frame. Hydraulic hose that resists oil is employed. These are items that the designer of road building equipment of not so long ago cared little about. Today, however, he has a far more responsible job, and now even pneumatic tires come under his jurisdiction. The scraper under discussion is equipped with tires of unusually large size, giving the unit increased mobility and eliminating the miring tendency of the old style flat steel wheel.

Certain manufacturing difficulties confronted the engineers in building a unit of this size, many of which were solved by the use of shielded arc high tensile electrodes. Production was appreciably facilitated by a revolving jig that permitted an increase in welding speed and a more perfect weld, eliminating overhead welding. Considerable saving in weight was effected by the welded construction and use of Man-Ten, a low alloy, high tensile steel with a strength of approximately 85,000 pounds.

This material, together with molybdenum alloy steel, carbon manganese alloy steel castings, antifriction bearings, and the hydraulic and electrical control devices have been combined to produce a scraper that is an excellent example of refinement in road building machinery.

Special Motors and Controls Simplify Design

By Herman A. Smith

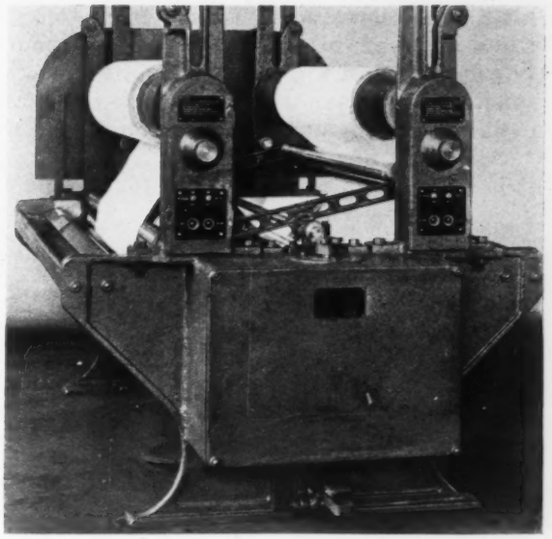


Fig. 1—Electrical control provides exact regulation in the process of dyeing cloth

WHEN the capabilities of a machine are limited by the means employed to achieve the action, and characteristics are desired which are beyond the scope of the devices used, the wise designer discards the usual methods and turns to something entirely new. One means of escaping the limitations of current designs is the application of the latest developments in electricity and the most modern electrical controls. These units regularly permit a reduction in the number of mechanisms in the machine, besides providing controlling forces which can be adapted to perform exactly the motions required.

In the design of the Rice, Barton & Fales dye jig, *Fig.* 1, considerable complexity was eliminated by the substitution of such electrical controls and unique electric motors for involved mechanical movements. The principle of this drive is a radical departure from the usual method of driving a dye jig. As can be seen from *Fig.* 2, each jig is provided with two motors, and each of these motors is geared directly to one of the beam rolls. There is no mechanical connection of any kind between the two motors so that when the power is shut off it is possible to revolve each roll and motor by hand independent of the other.

Armatures Are in Series

The motors are wired so that the armatures are in series and the fields in parallel, thus creating an electrical differential. Patents which cover the method of wiring are controlled by the Sir James Farmer Norton Co. of England, and Rice, Barton & Fales are the sole manufacturers in this country. As wired, the two motors form the driving unit and the line current, usually 230 volts, feeds them, the amount of current going to each varying according to the speed of that motor. When the motors are running at the same speed, each is taking 115 volts, as the sum of the voltage at any point during the run will always be 230 volts. At no time during the dyeing of the cloth does either motor take the full voltage.

The dyeing speed of the machine is 85 yards per minute. This speed cannot be varied during the regular running of the machine, and must remain constant at all times. It is the basic characteristics of the motors which permits the maintenance of this speed. As the roll of cloth on the winding beam slowly builds up in diameter, the load on the motor driving that roll increases proportionately with every revolution. This increase in load causes the speed of the driving motor to decrease slowly, and consequently this motor draws less current. The remainder of the 230 volts is then drawn by the trailing motor and as this remaining current is constantly increasing, so the speed of the trailing motor slowly builds up as the amount of cloth on that roll diminishes. The result of all this is that although the revolutions of the beam rolls and motors are constantly changing, yet the speed of the cloth passing through the dye is virtually constant.

As noted in the foregoing, constant tension is another important requirement of the machine, and this tension must be variable for the dyeing of delicate fabrics such as all silk-satins, rayons, all-celanese, mixtures of rayon and celanese, and even crepes. Also, this tension control must be so smooth in operation that even the most delicate fabrics may be handled without creases or moire markings. The trailing

motor, because of its being a generator, has a tendency to act as a brake, and it is this action that is utilized to control the tension of the cloth.

In the circuit, between the two motors, *Fig.* 2, is a bank of resistance controlled by a rheostat plate. Cloth tension may be varied by adjusting the rheostat to change the amount of electrical resistance. This gives a tension variation between "drum-tight" and a looseness that barely turns the immersion rolls, yet once the tension has been set to suit requirements, it cannot vary throughout the length of the run.

Although speed of running cannot be varied, it is sometimes of advantage to be able to vary

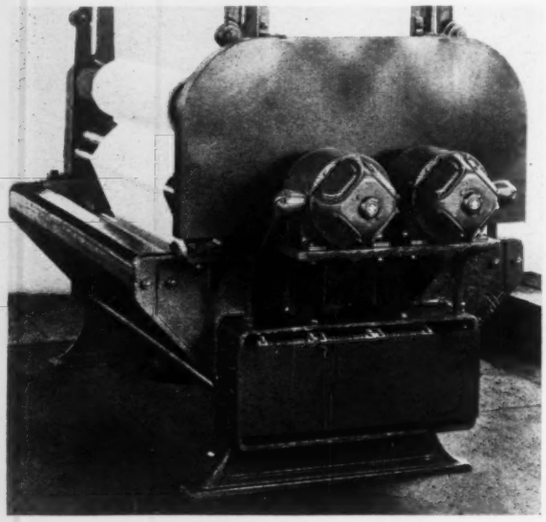


Fig. 2—Two motors, each geared directly to one of the beam rolls, are utilized in the design

the speed when the cloth is being threaded into the machine. A conveniently located toggle switch, marked "Tension" and "Speed" has been incorporated in the design so that when the machine is being loaded or unloaded this switch is thrown to the "speed" position. This action automatically disconnects the trailing motor electrically and then the speed of the driving motor may be varied by adjusting the rheostat mentioned in the foregoing.

Two "Start" and two "Stop" buttons are provided, *Fig.* 1, and either beam roll may be started in the winding direction by pressing the "Start" button on that particular side of the machine. The jig may be reversed by pressing the second "Start" button and it may be stopped by pressing either of the "Stop" buttons at any time. In starting or reversing, a timing relay provides an acceleration period of approximately four seconds during which time only the driving motor is in operation. At the end of this period the relay automatically closes, the second motor comes into operation, and the speed becomes stabilized.

An automatic reversing device, the control knob of which may be seen projecting through the cover of each of the upper frames in *Fig.* 1, is directly connected to the journal of each of the beam rolls. When half a dozen thicknesses of cloth at the beginning of the run have been wound on the beam roll, the reversing device may be set by pushing in the control knob and rotating it one revolution. The reverse toggle switch on that side of the machine is then snapped. When this same cycle of operations has been completed at the other end of the cloth, the jig will automatically reverse at each end of the piece goods. Even if the cloth should change appreciably in length, reversals will still take place at exactly the same place, as the reversing device is positive in action.

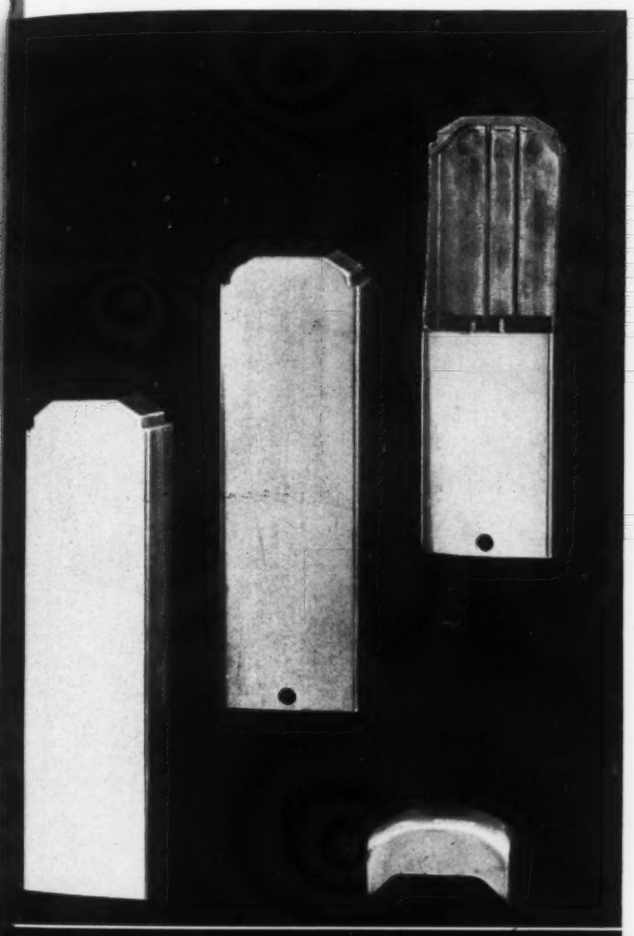
Machine Rocks Automatically

Another problem in the design of this machine was the need for providing means of continuing motion of the beam rolls without advancing the cloth during the time when the dyer is having his samples tested. It is not desirable to leave the roll of cloth stationary on account of the dye sinking to the lower side of the roll. When this happens certain classes of goods become dyed unevenly. In the old style jig the only way to overcome the difficulty was to let all of the cloth run on to one beam roll and keep this beam roll slowly rotating, thus losing the end. In the new machine, electrical controls again solved the problem by enabling the incorporation of a rocking device. When the switch marked "Rock" is snapped on, the loaded beam roll will rotate alternately clockwise and counterclockwise one revolution, and thus the dye is not allowed to concentrate at any part of the roll. When this switch is snapped off the machine automatically returns to its normal running condition.

The design of this dye jig has not only taken into consideration the operating means, but has also covered all parts of the unit. For example, the tank is of stainless metal, sufficiently heavy to be electrically welded at all seams.

A rubber valve in a seating of stainless metal is bolted to the bottom of the tank and is operated by the foot pedal seen in *Fig.* 1. Beam rolls are of heavy steel pipe covered with hard rubber, not only on the face but also down the ends to prevent the rubber from breaking away from the roll. A rocker type spreader is supplied with each jig, and all lead rolls, not only on this spreader but also in the tank, are carried in stainless steel ball bearings especially designed for this class of work. The motors are protected by special dye house insulation and the control panel is carried in the heavy watertight cabinet at the front of the machine. Controls employed in the machine are manufactured by Cutler-Hammer Inc.

Producing Aluminum Parts by Impact Extrusion



FEBRUARY 23, 1936, marks the fiftieth anniversary of Charles Martin Hall's discovery of the electrolytic process for the production of aluminum. Hall's discovery, made when he was but twenty-two years of age, is the basis for the present-day method of manufacturing aluminum. It made possible a drastic reduction on the price of the metal and paved the way for the extensive use of aluminum today, an unusual development is impact extrusion

IMPACT extrusion is one of the most versatile of all processes developed for working aluminum. By means of it, shapes which would require several different forming operations by any other method can be produced in one operation. Impact extrusion is usually done cold. On large presses operating at high speeds, simple slugs of metal are converted by a single blow of a punch into many unusual shapes—shapes which would prove costly if produced by any other process or sequence of processes.

The articles shown in the accompanying illustrations will give the designer an idea of the versatility of the process by which they are formed as well as a conception of the ease with which aluminum may be worked and shaped.

A rectangular seamless container is shown in various stages of manufacture in *Fig.* 1. For the major portion of its length the box is 1/32 inch in wall thickness, but at the closed end its thickness varies as shown in the sectioned view at the upper right. Furthermore, there are pairs of formed ridges on each side of the interior of the box. The rectangular section alone would make the box a difficult problem in drawing, but the thickened end and the ridges would make it practically impossible. How-

(*Concluded on Page* 40)

Fig. 1—*Top—One operation will produce this complex box-like section. Fig.* 2—*Below—Part is formed by extruding the metal downward*

Stress Concentration Leads to

By Willis G. Meyers

Fig. 1—Typical fatigue failure in a connecting rod. Crack started in the fillet and spread radially, as shown by circles, until sudden failure finally occurred in upper flange. Photo courtesy General Motors Corp.

ONE OF the most important factors influencing the fatigue strength of forgings is the grain flow. The dies should be so designed that the grain flow is continuous from end to end of the part. This is particularly important in such parts as crankshafts, and the ends of the fibers should not come to the surface except at the two ends of the forging. Crankshafts should be split and deep etched to show up the grain flow in order to check the quality of the forging. Grain flow is a frequent cause of crankshaft failures.

The influence of grain size and other variations in materials, the general problem of fatigue and the need for careful design to avoid regions of stress concentration and localized stresses was covered in the first section of this article presented on page 37 of the December issue of MACHINE DESIGN.

In connection with the subject of grain flow it might be well to mention the importance of proper forging temperatures. The forge shop, in order to increase the rate of production, is apt to overheat the steel. Temperature controls on modern furnaces have eliminated much of this trouble, but they cannot control the time in the furnace nor the character of the flame; that is, whether it is oxidizing or reducing. Continuous furnaces with temperature control eliminate the time element to a certain extent.

However, in spite of modern progress in steel treating equipment, proper education of the heater and hammer man are of vital importance. If they are carefully impressed with the fact that a burnt forging may cause serious damage in service and may even jeopardize lives, and are educated to reject all overheated parts rather than try to slip them past the inspectors, a higher grade of forgings will be prevalent. Burnt forgings cannot always be caught by surface inspection.

Should Establish Heat Treatment

Of equal importance is the matter of heat treatment. The temperatures and time cycles involved should not be left to the discretion of the furnace operator, but should be established under the direction of a competent heat treater or metallurgist who understands some of the principles involved. Instructions on a blueprint or specification sheet are not sufficient to produce good heat treatment. An operator with experience and good common sense should always be on the job.

One common fault in heat treating plants is the placing of thermo-couples. They should be placed in the furnaces as near the work as possible but not in contact with it. Neither should they be placed in the direct path of the flame. Thermo-couples should be checked frequently, and, when continuous furnaces are used, a traveling couple should be put into the furnace from time to time to check the operation of the furnace. It is especially necessary when forgings are to be used for aeronautical equipment or similar purposes, where rigid specifications are in force, to make use of every known device to insure accurate time, temperature cycles.

ads to Failure of Design

Part II

Properly designed gears manufactured from modern materials seldom fail through breakage of the teeth. When such breakage does occur it is generally the result of something other than the lack of proper physical properties. The majority of failures are due to some form of failure of the surfaces of the teeth that carry the loads. Such failures are due to wear and may be caused by any of the following causes: Pitting, galling, spalling, peening, scuffing, or abrasion.

The ability of the steel to withstand tooth breakage is governed by its strength and toughness. Toughness is defined as the ability to withstand impact loads without fracture or undue deformation, and is measured by the relation of the yield point to the ultimate strength, reduction of area, and elongation.

Brittleness Is Detrimental

While great strength is desirable, accompanying brittleness or lack of ductility is detrimental. Therefore, if shock loads are involved a steel of the maximum possible toughness commensurate with the necessary strength should be used.

The hardness penetration from surface to core is an important factor which is often neglected. The hardness drop is an indication of the toughness, but the actual strength is not that indicated by the hardness of the steel at the surface. The strength should be calculated on the basis of that at the base of the tooth, where the stress is highest. In the accompanying table is given the hardness at different depths from the surface for the same gear made from three different materials, treated to correct hardness. The physical properties at both the surface and the root of the teeth are given in the lower part of the table. A study of the table makes it obvious that the strength of the teeth according to the Lewis formula should be calculated from the physical properties at the root of the tooth. In each case the strength at the root is much less than at the surface of the gear, but the toughness, as indicated by the reduction of area and elongation, is much greater.

Fig. 2—Shank of this connecting rod which had an unusual failure was originally in the shape of an "I" beam. Crack started near junction of web and upper flange and spread a considerable distance before failure finally occurred in upper and lower flanges. Just prior to failure shank of the rod buckled. Photo courtesy General Motors Corp.

The problem of selecting the proper steel for a gear for a given purpose is rather difficult because we are at a loss for a suitable criterion. In many cases it has been found that where a steel of apparently suitable physical properties failed through excessive wear, other steels having the same or lower properties were successful in the same application. In many cases no reason for the failure of the original material can be ascertained and it is believed that there is still much to be learned in the matter of selecting gear steels. Most designers use the same steels

that others have used in similar applications, and while this is not progressive, it certainly is the most reliable method and is justified in many cases. However, proper consideration of the known factors governing gear operation should also be applied in the majority of cases.

Probably the best and most reliable criteria available at present are the hardness, grain size, and structure. In general it may be said that the harder the surface, the finer the grain size, and the more uniform the structure, the higher will be the wear resistance of the steel.

A case hardened pinion running with an oil-treated gear treated to a brinell hardness at which the teeth may be cut after heat treatment, is an excellent combination where the gear ratio is high and there are no shock loads. The pinion, being relatively small, is subject to little distortion, and distortion of the gear is eliminated by cutting the teeth after heat treatment.

Strength Is Not Great

The core of the plain carbon case hardening steels is soft and ductile but the strength is not great. The case hardening alloy steels have a soft and tough core of considerable strength, the degree being dependent upon the alloying elements. With either the carbon or alloy case hardening steels the core strength and toughness can be improved by the use of a double quench, although it can never approach the properties of the full hardening steels.

Although the core of the case hardening steels is soft and ductile and therefore shock resisting, the case is extremely hard and brittle. If the hardness were evenly graduated from the surface to the core, a very tough and shock resisting material would result, but the change from the hard case to the soft core, unfortunately, takes place in a very narrow zone. For that reason case hardening steels, particularly the plain carbon varieties, are not suitable for impact or severe shock loads.

Full hardening steels are used when great strength, toughness, wear resistance, and shock resistance are required. Fairly high surface hardnesses are obtained with these steels, although not so high as in the case hardening types. For that reason the wear resistance is not quite so good, but when great strength and shock resistance are necessary there is no alternative.

Full hardening steels, like any other steels, require a drastic quench to obtain the desired physical properties, and this often results in distortion during the hardening process. Therefore, grinding or lapping of the teeth is necessary after hardening in order to assure that the tooth profiles are true.

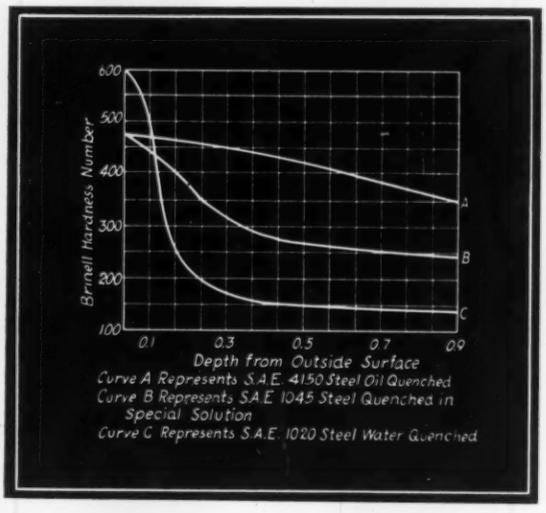
In cases where the teeth are to be cut after heat treatment the steel is quenched and drawn to a fairly high temperature so that it is within the range of machinable hardness. Steels of this class are generally referred to as "heat treating" steels to distinguish them from the full hardening types.

Teeth May Be Rough Cut

As the physical properties and wearing qualities are proportional to the hardness, steels of this type obviously cannot be quite as strong or wear resisting as the other types. Owing to the high percentage values of reduction of area and elongation, they are extremely tough and shock resisting, and the lack of strength is somewhat compensated for by the elimination of increment loads due to inaccuracies. In some cases, especially in the larger gears, the teeth are rough-cut before heat treatment and finish-cut after treatment to insure the desired physical properties throughout the teeth.

When we consider fatigue failure, localized stress at once becomes vitally important. Every minute area subjected to high localized stress must be considered as a possible nucleus for the start of a spreading crack and hence of a fatigue failure. In this connection the phenomenon of corrosion fatigue is of interest. If a metal be subjected simultaneously to repeated loading and the action of a corrosive agent its fatigue strength is greatly reduced. Dr. D. J. McAdam

Comparative physical properties of steels used for gears. Hardness ranges taken at different depths



	S. A. E. 1020		S. A. E. 1045		S. A. E. 4150	
	Surface	Root	Surface	Root	Surface	Root
Ultimate strength	295,000	93,000	234,000	145,000	250,000	170,000
Yield point	274,000	66,000	211,000	99,000	220,000	156,000
Reduction of area, per cent	.....	50	.....	44	35	60
Elongation in 2 inches, per cent	.....	16	.....	17	8	16
Brinell hardness	600	140	477	245	477	350

Mechanical Properties and Strength-Weight Ratios of Various Materials

Metal	Treatment	Dens. D	Tensile Strength Psi	÷D*	Proportional Limit Psi	÷D*	Charpy Impact Ft. lbs.	÷D	Endurance Limit Psi	÷D*	Corrosion Fatigue Limit Fresh Water Psi	÷D*	Brackish Sea-water Psi	÷D*
MONEL METAL	Annealed	8.8	81,900	9.3	25,000	2.8	.....	.....	35,000	4.0				
	Partially hard	.....	83,000	9.4	40,000	4.5	63.0	7.2	.....	.....	21,000–24,000	2.4–2.7	27,000–29,000	3.0–3.3
	Hard	.....	127,200	14.5	82,000	9.3	51.4	5.8	50,000	5.7				
NICKEL	Annealed	8.84	77,600	8.8	19,000	2.1	.....	.....	35,000	4.0	21,000–24,000	2.4–2.7	20,000–22,000	2.3–2.5
	Hard	.....	131,700	15.0	85,000	9.6	65.8	7.7	50,000	5.6				
COPPER	Annealed	8.85	31,200	3.5	.....	.....	29.4	3.3	10,000	1.1	.....	.....	.....	.....
	Hard	.....	46,500	5.2	9,200	1.0	18.0	2.0	17,000	1.9	.....	.....	.....	.....
BRASS (70-30)	Annealed	8.5	45,000	5.3	.....	.....	36.8	4.3	.....	.....	.....	.....	.....	.....
	Hard	.....	73,000	8.6	.....	.....	14.2	1.7	.....	.....	.....	.....	.....	.....
ALUMINUM	Annealed	2.7	12,600	4.7	.....	.....	.....	.....	6,000	2.2	4,000–5,000	1.5–1.8	2,500–3,500	0.93–1.3
	Hard	.....	20,800	7.7	10,500	3.9	16.1	6.0	8,000	3.0				
DURALUMIN	Annealed	2.85	33,400	11.7	15,100	5.3	.....	.....	14,000	4.9	7,000–9,000	2.45–3.15	6,000–8,000	2.1–2.8
	Heat-treated	.....	69,100	24.3	36,800	13.0	10.1	3.5	18,000	6.3				
STEEL (0.16% Carbon)	Water-quenched and drawn at 900° Fahr.	7.85	65,700	8.3	37,200	4.7	54.7	7.0	85,000	4.5	20,000–23,000	2.5–2.9	6,000–9,000	0.76–1.1
STEEL (0.49% Carbon)	Water-quenched and drawn at 1000° Fahr.	7.85	110,900	14.0	65,800	8.4	19.4	2.5	53,000	6.7	20,000	2.55	.....	.....
CHROME-VANADIUM STEEL	Oil-quenched and drawn at 1000° Fahr.	7.85	150,600	19.0	87,500	11.0	17.7	2.2	68,000	8.6	18,000–20,000	2.3–2.5	.....	.....
NICKEL STEEL (3.7%)	Water-quenched and drawn at 1000° Fahr.	7.85	130,400	16.7	90,700	11.5	29.0	3.7	.....	.....	.....	.....	.....	.....
CHROME-NICKEL STEEL	Water-quenched and drawn at 1000° Fahr.	7.85	138,250	17.6	96,700	12.3	30.6	3.9	.....	.....	.....	.....	.....	.....
CHROME-MOLYB-DENUM STEEL	Oil-quenched and drawn at 1000° Fahr.	7.85	117,600	15.0	81,000	10.3	39.6	5.0	.....	.....	.....	.....	.....	.....
CHROMIUM IRON 14.5% (High Carbon)	Oil-quenched and drawn at 1200° Fahr.	7.7	117,400	15.0	41,200	5.2	13.4	1.7	54,000	7.0	36,000–38,000	4.6–4.8	25,000–30,000	3.2–3.8

Values given are from McAdam.
*Values shown should be multiplied by 1/1000.

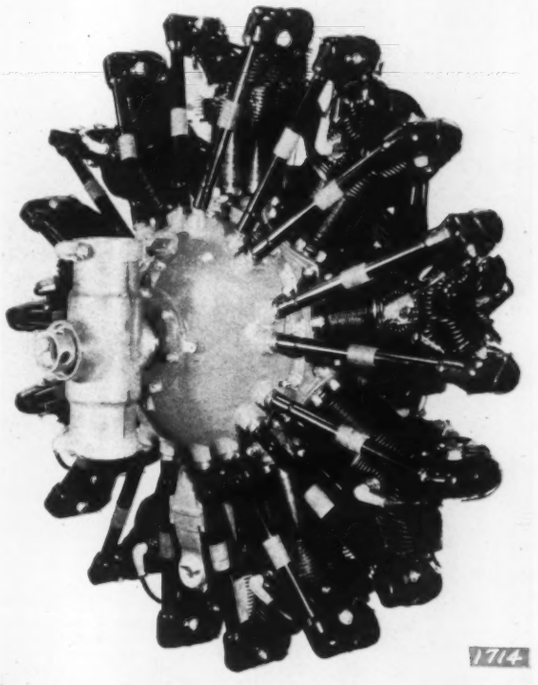


Fig. 3—The aeronautical industry has been predominantly instrumental in bringing about the quantity production of fine quality steels

Jr., of the United States Naval Engineering Experiment Station at Annapolis, is the leading investigator in this field, and he has found that under such action there is a tendency for the corroding medium to cause minute pits.

So mild a corrosive agent as ordinary fresh water may reduce the fatigue strength of steel by more than fifty per cent, and the effect is relatively worse in the case of heat treated alloy steels than in that of the cheaper carbon steels. The effect of simultaneous corrosion and repeated stress is much greater than that of either of them acting alone or of the two acting at different times. The stress seems to accelerate the rate of pitting and the pitting causes concentration of stress and thus contributes to premature failure.

Gages Corrosion Fatigue

The principle factors involved in corrosion fatigue are susceptibility of the metal of pitting, corrosiveness of the agent, time, cycle frequency, and the stress. The corrosion fatigue behavior of metals is gaged by comparing the stress that will cause failure under combined cyclic stress and corrosion conditions with the endurance limit of the metal.

In cases where weight is at a premium and close figuring on mechanical properties is therefore required, the use of a corrosion-resistant metal is of advantage, as its physical properties are more stable and it is less likely to be affected by corrosion fatigue. The extent to which the strength of a metal part is lowered by pitting due to corrosive agents is far out of proportion to the actual reduction in cross-sectional area due to the pit, so that the importance of maintaining parts free from corrosion is doubly significant.

On a purely mechanical basis certain metals appear to have advantages, but such advantages are often modified by chemical deterioration, so that a consideration of the corrosion-resisting materials with more stable, though sometimes inferior, mechanical properties is warranted under some conditions.

THE END

Forecasts on "Tomorrow's Car"

CONTROL of the future automobile will be completely automatic, the majority of engines will be in the rear, running boards will be eliminated, interior space increased, and seats will be more numerous and removable, rotary valves are scheduled for a come-back, and there will be two-cycle engines. These are the opinions of several automotive experts who contributed to the symposium on "The Car of The Future" at the annual meeting of Society of Automotive Engineers. While mechanical predictions were not unanimous, there was a surprising agreement on body styles, and the automobile buyer of the future will make his selection from cars which follow the design of today's Stout Scarab to a surprising degree as evidenced by the following predictions.

In the opinion of Austin M. Wolf, automotive consultant, engine displacements in general will not increase while in a number of cases they will be less. Greater output will be attained by higher engine speeds and refinements, and superior car performance by the decrease in car weight. Intermediate speed characteristics under part and full throttle positions will be the objective rather than maximum power output at top speed. Torque output will be discussed rather than horsepower.

Forecasts Rotary Valves

Mr. Wolf believes that inherent valve ills will lead to renewed experiments with the rotary type. A valve will be developed which will give greater output due to better volumetric efficiency and the elimination of hot spots, permitting increased compression ratios. Backlash and reciprocating parts will be avoided. Magnesium alloy pistons will be popular because of high engine speeds, a hard surface being obtained by an electrolitical coating. The slipper design of the skirt will be generally used to attain minimum weight. Thus all rings will be above the wrist pin.

To insure better lubrication with cold starting, the starting motor will, in some cases, drive the regular pump through an overrunning ratchet or a separate pump, either of which will be timed to operate before engagement of the flywheel ring gear to exert pressure and cause partial flow in the lines. One design may include spurt nozzles aimed at the cylinder walls while another engine might be provided with drilled leads to the bores.

In the symposium, Herbert Chase, automotive consultant stated, "Compactness without sacrifice in accessibility can doubtless be achieved in several ways. It certainly does not lie in the use of vertical in-line engines placed longitudinally in the vehicle. Even radial or barrel type engines appear to have possibilities. I think the two-stroke engine deserves study and may prove to be a possible answer to the problem, especially as it promises to be compact and certainly is more economical at part load than the conventional engine, which are points very much in its favor.

Fan May Be Driven Separately

"Cooling problems are sometimes magnified unnecessarily in considering rear engines. One simple solution is to place the radiator at the front of the car and to use a thermostatically-controlled electric motor to drive a fan placed back of it. This can be employed to ventilate and heat the body in winter if desired. It is only one of several solutions, however.

"A much more difficult problem is that of power transmission, and especially gear changing or its equivalent. I shall not attempt to predict the optimum arrangement. It may be entirely automatic, in which even control will be greatly simplified. It may involve a remote control of the electro-vacuum type, one form of which is now available and quite well tried, though rather complex. There are certainly many other possible solutions, hence there is little need to delay rear engine arrangements on this score."

A standard feature of the future automobile will be air conditioning. In the words of Amos E. Northrup, chief designer, Murray Corp. of America, "Air conditioning is just as surely coming to the automobile as it has to the home. When the car is properly air conditioned and ventilated, no window will open except the driver's, which will be free to open for safety purposes. This will do away with the need of regulators with the exception of this one window and some other means of raising and lowering will be found. In the car incorporating proper air conditioning and ventilating, the problem of heating will also be solved."

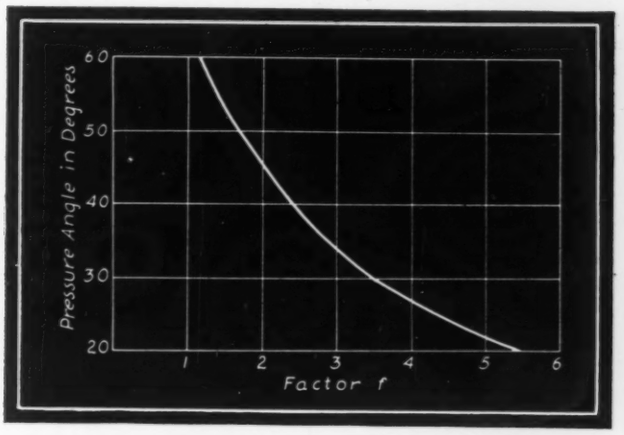


Fig. 1—Factor for the given maximum pressure angle may be obtained from this chart

Parabolic Cams

Smooth Velocity Curves

By George T. Chapman

UNIFORMLY increasing velocity from the beginning to the middle of the stroke, then a uniformly decreasing velocity to the end is provided by the parabola cam. The acceleration of the follower is constant during the first half of the stroke, and the retardation is constant during the last half. Acceleration and retardation values are equal, and are less than the maximum value of any of the other base curves, with a result that the direct effort required to turn a positive acting parabola cam is less than for any other type of positive cam, a fact well worth considering in the design of machinery.

In order to arrive at the radius of the pitch circle or the size of the cam, the following formula can be used:

$$r = 57.3\frac{hf}{b} \text{ or } 0.159\frac{hf}{e}$$

where

b = angle in degrees, turned by cam while follower moves distance h
e = angle in fraction of revolution turned by cam while follower moves distance h
f = factor for given maximum pressure angle. See *Fig.* 1
h = distance traveled by follower
r = rradius of pitch circle

As an example, suppose the follower is to rise 1 inch in 60 degrees movement of cam and the maximum pressure angle is to be 30 degrees. We then have:

$$r = 57.3\frac{hf}{b} = 57.3\frac{1 \times 3.46}{60} = 3.304''$$

In order to construct the cam

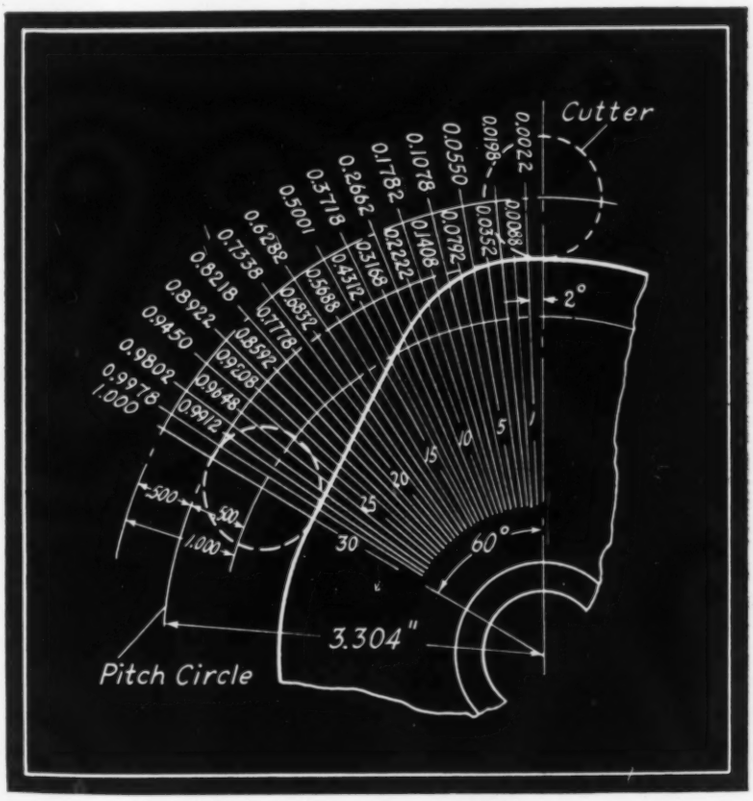


Fig. 2—Careful plotting of the cam details aids in the efficient development of the part

profile in a cam milling machine, the cam is mounted on the mandrel and advanced toward the cutter while the cam revolves through a given angle. In milling the cam, the cutter should be of the same diameter as the follower roller that works in connection with the cam.

In *Fig.* 2 the working angle is 60 degrees and the throw 1 inch; therefore, if we take 2 degrees as the angle increment, we have 60/2 or 30 spaces. 1.00/2 = 0.500 inch which is the radial increment at the center or 15th radial line. It is now necessary to divide 0.500 into 15 parts which are proportional to the progression of 1, 3, 5, 7, 9, etc. up to 29.

These figures should be set down as shown in Table I, where column A represents the number of the term, B the series number, C the sum of the consecutive terms and D the value of the increments found by multiplying the numbers in column C by the first increment, which is the quotient of one-half the total rise divided by the

TABLE I

Cam Proportions

A	B	C	D
1	1	1	0.0022
2	3	4	0.0088
3	5	9	0.0198
4	7	16	0.0352
5	9	25	0.0550
6	11	36	0.0792
7	13	49	0.1078
8	15	64	0.1408
9	17	81	0.1782
10	19	100	0.2222
11	21	121	0.2662
12	23	144	0.3168
13	25	169	0.3718
14	27	196	0.4312
15	29	225	0.5000

total sum of the series in column C. The increments on the opposite side of the curve may be obtained by subtracting the numbers in column D from the total throw.

In order to better understand the action of this cam, refer to *Fig.* 3 in which *G H* represents the time unit in which the follower rises one unit, *H J* the same time unit in which the follower rises three units, *J K* five units and *K L* seven units. It will be noted that the follower travels two units further in each succeeding time unit which results in uniform acceleration.

Referring to *Fig.* 3, if it is desired to divide *C B* into six parts instead of eight, *C E* should be divided in nine equal parts instead of sixteen as shown.

As will be noted, *A B* represents the total rise of the follower and *B C* = factor *f* taken from *Fig.* 1. The tangent to curve *B D* at point *L* will make an angle of 30 degrees with *L F*. *G F* will represent the pitch line.

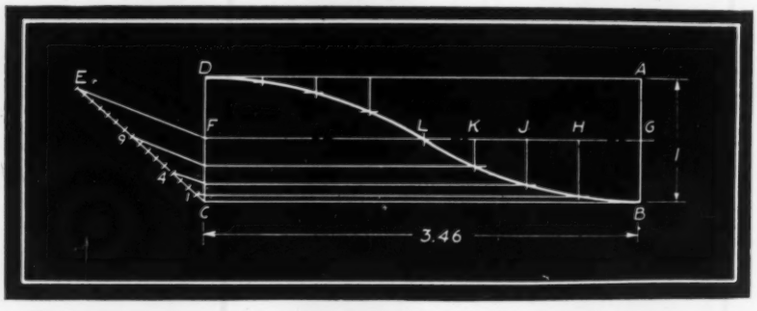


Fig. 3—Action of a parabolic cam is illustrated by chart which has time plotted against the rise of the cam

Producing Aluminum Parts by Impact Extrusion

(*Concluded from Page* 33)

ever, all these details can be taken care of in one operation by impact extrusion.

The operation begins on the odd-shaped blank shown at the lower right. This is blanked and formed from heavy aluminum plate. The blank is placed in a die recess of the same cross section, but having a bottom shaped to match the end of the finished box. A lipped punch, which clears the die by 1/32 inch all around and is beveled at the end along its short edges, is driven into the die with a single powerful blow, causing a wall of metal to shoot up around the shank of the punch. The punch is then withdrawn, carrying with it the extruded piece which is stripped off mechanically.

A variation of the process is illustrated in *Fig.* 2. The manufacture of this part differs from that of the other in that the metal is extruded downward through the clearance between a hole in the conical bottom of the die and cylindrical extension on the punch, rather than being extruded upwards.

The slug used is blanked out of heavy sheet and cupped to a 120-degree angle. The punch has a conical portion with a cylindrical extension slightly less in diameter than the hole in the die. One-fourth of an inch above the edge of the conical part is a shoulder which brings the diameter up to that of the die. This is to prevent the metal from extruding upward. After extruding and trimming to length, the angled shoulder of the part is pressed to a rounded contour. The pipe portion is then swaged to a taper and the piece is finished by putting four flutes in the walls of the spout.

New Machines Indicate Design Trends

ONE of the most encouraging characteristics of the design profession is reflected by the fact that the trends revealed in announcements of new machines are not sudden whims, tacked on to the machines in an effort to get something new. Designers do not follow this course. Before any part, any mechanism, any material, becomes an integral part of a new machine it has been considered from every angle by careful engineers. The new part spends weeks, and even months, in the design department, more weeks on the board, and finally emerges as an innovation on the machine. Every new developmen must follow this procedure.

Machines recently announced in addition to those on the next two pages include the following, arranged by fields of application:

Brewery

Bottle Washer, Michael Yundt Co., Waukesha, Wis.

Chemical

Disperser, Lancaster Processes Inc., New York.

Automatic Extractor, Harding & Stephens Co., Paterson, N. J.

Construction

Self-Propelling Bituminous Paver, Jaeger Machine Co., Columbus, O.

Diesel Powered Shovels, Thew Shovel Co., Lorain, O.

Combination Shovel, Dragline and Crane, Lima Locomotive Works, Lima, O.

Dairy

Two-Stage Homogenizer, Gardner Dairy Equipment Co., Grand Rapids, Mich.

Steam Sterilizer, Strauss Electric Appliance Co., Waukesha, Wis.

Domestic

Electric Refrigerators, Kelvinator Corp., Detroit.

Electric Fans, Emerson Electric Mfg. Co., St. Louis.

Automatic Furnace Feeder, Taylor Equipment Co., Cincinnati.

Electric Fans, Wagner Electric Co., St. Louis.

Food

High Speed Mixer, Read Machinery Co., York, Pa.

Flaxing Mill, Allis-Chalmers Mfg. Co., Milwaukee.

Cylinder Separator, Superior Separator Co., St. Paul, Minn.

Industrial

Compressor, Allis-Chalmers Mfg. Co., Milwaukee.

Bowl Mill, Combustion Engineering Co., Inc., New York.

Unit Heaters, Electric Air Heater Co., Mishawaka, Ind.

Laboratory Hammer Mill, American Pulverizer Co., St. Louis.

Metalworking

Motor Driven Bench Lathe, South Bend Lathe Works, South Bend, Ind.

Die Sinking Machine, Mall Tool Co., Chicago.

Electric Furnace, Detroit Electric Furnace Co., Detroit.

Automatic Screw Machine, Windsor Automatic Co., Windsor, Vt.

Grinding Machine, Hill Clutch Machine & Foundry Co., Cleveland.

High Speed Tube and Bar Straightening Machine, Sutton Engineering Co., Pittsburgh.

Mining

Pulverizing Bowl Mill, Raymond Bros., Chicago.

Electric Dust Recorder, Mine Safety Appliances Co., Pittsburgh.

Office

Automatic Typing Machine, Automatic Business Machines Inc., Pittsburgh.

Printing

Roll Feed Gravure Presses, Rotogravure Engineering Co., New York.

Quarry

Crusher, Cochrane Corp., Philadelphia.

Rubber

Centrifugal Washer, Rochester Engineering & Centrifugal Corp., Rochester, N. Y.

Rubber Testing Machine, National Rubber Machinery Co., Clifton Division, Clifton, N. J.

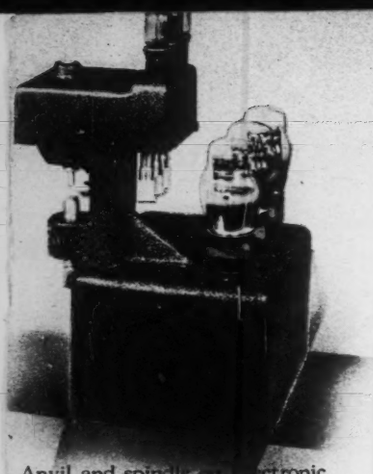
Stores

Refrigerating Units, Frick Co., Waynesboro, Pa.

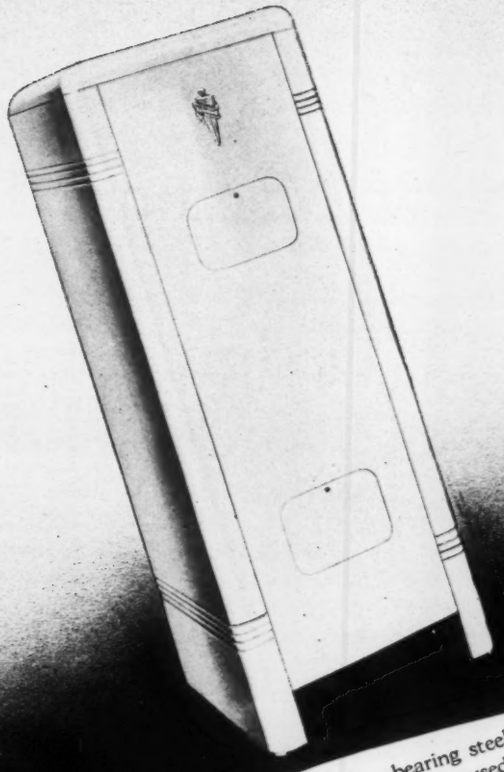
Beverage Coolers, Kelvinator Corp., Detroit.

Textile

Fabric Wear Testing Machine, Shawmut Engineering Co., Boston.

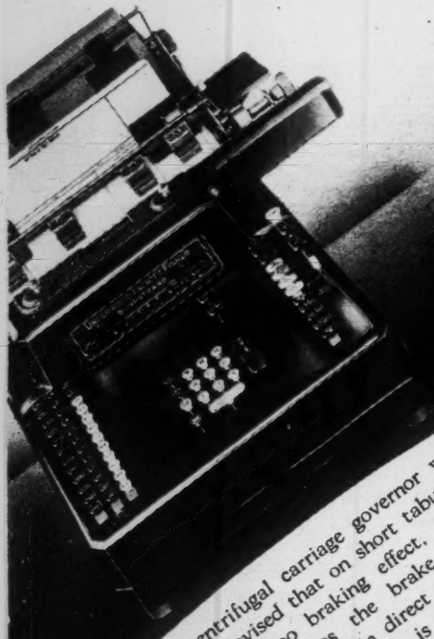


Anvil and spindle on electronic inspection gage are closely coupled through a homogeneous metal which compensates for temperature expansion in the instrument. Regulator, anvil and spindle are readily adjustable.



Galvanized copper-bearing steel of all welded construction is used for the tank in new Kelvinator water heater. Heating element is made of heavy resistance wire and enclosed in a housing welded to the side of the tank.

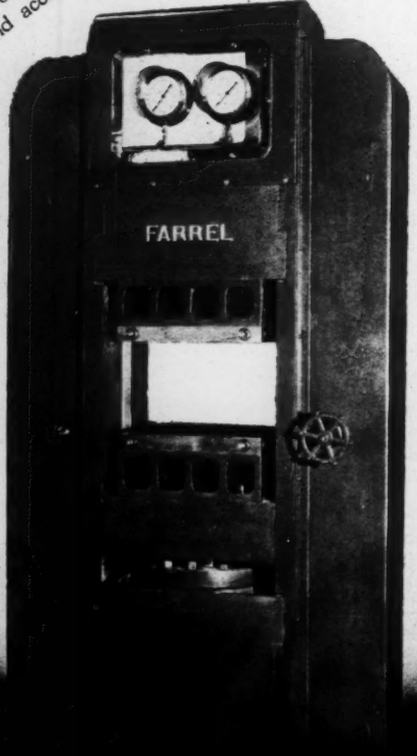
Portable electric unit water heat has a hou gage steel and a base o which offers no radia into this Hexcel unit. used a six-inch alumin



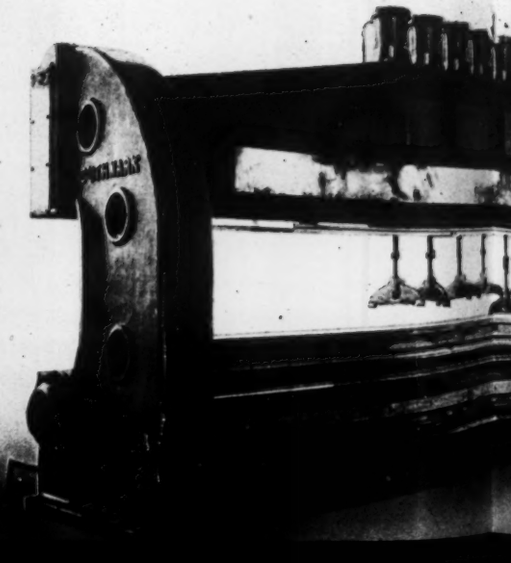
A centrifugal carriage governor which is so devised that on short tabulations it exerts no braking effect, while as speed increases the brake functions with a pressure in direct ratio to the speed of the carriage, is used on Sundstrand accounting machine.

Design F in New M

A Pictorial Presentation from the Standp



Variable displacement pump with its driving motor is mounted over the top crosshead, the crosshead also serving as an oil reservoir, on Farrel-Birmingham press for plastics and rubber molding. A self-contained hydraulic power unit using oil as the fluid medium drives the machine.



Twenty-four pneumatic hold-downs or grips lock plates on the working table of new Baldwin-Southwark electrically fed plate planer. Drive screw is made in one piece, fifty nine feet long overall, has a quintuple thread and runs on roller bearings. The carriage automatically reverses itself at each end of the stroke.

lectric unit for providing hot
has a housing drawn of heavy
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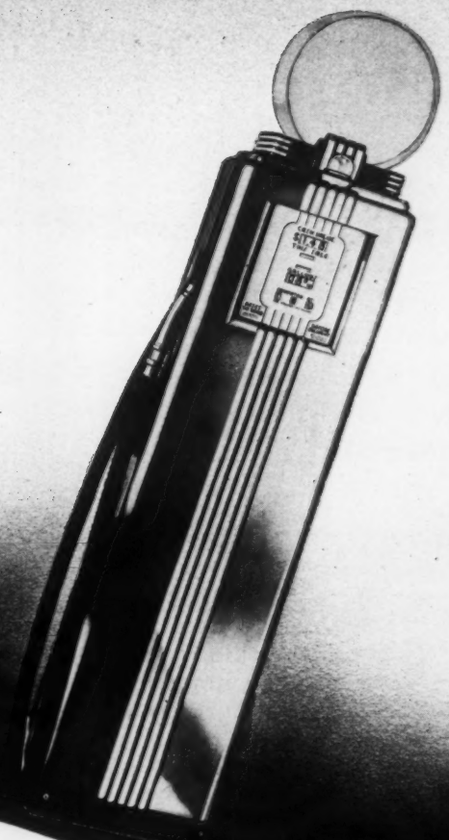
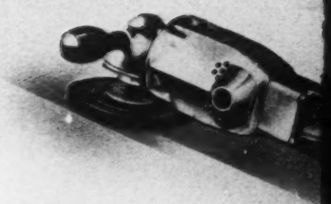


One die is used for both the front and the back in new design of Erie gasoline pump. The machine, designed for appearance by Wilbur Henry Adams, takes a standard globe and has a receding base.



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Light beam to be analyzed in General Electric recording photoelectric spectrophotometer passes through a rochon prism mounted in the hollow shaft of a high-speed synchronous motor. Rotation of this element serves to vary the light intensity of the incident beams from minimum to maximum.

n Features
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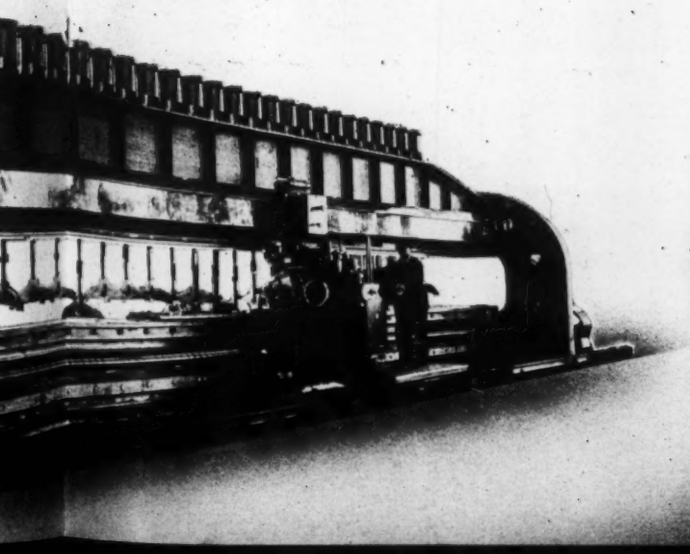
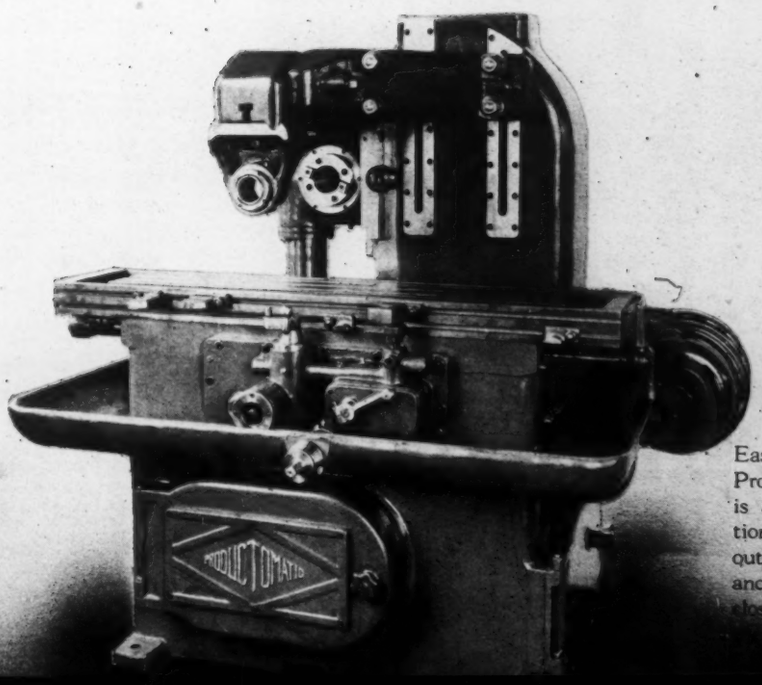
Standpoint of Design.





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MACHINE DESIGN

Western Civilization Owes Present Status to Design Work of James Watt

IN WHAT state of civilization would we be today had it not been for the acumen of the brilliant engineer born two hundred years ago—James Watt—whose bicentenary recently was celebrated in all parts of the world? Without detracting from the efforts of his contemporaries, it is to him primarily that engineers owe a debt of gratitude for the advancement of the profession made possible by his work—and it is from his success that they are able to obtain their most heartening stimulus for achievement.

Any study of the life of Watt reveals the relentlessness with which he pursued, often under straitened conditions, his early researches in perfecting the steam engine. Fortunately from the financial standpoint Watt had, during his work as a mathematical instrument maker, acquired numerous friends who stood by him in furnishing funds with which to continue his work.

It has been said that Watt not only improved the steam engine to the point that it was placed in common use in collieries and locomotives but also that he might be termed a pioneer in interchangeable manufacture, later to be perfected by Whitney. His engines, admittedly crude and "handmade" in the early stages, were produced before his death on what came close to being a production basis.

Though many designers do not receive, for one reason or another, their just reward, the celebrations held in honor of James Watt cannot fail to encourage and stimulate his counterparts of today.

Know Your Alloys?

FURTHER evidence of the increasing use of alloys is available from the fact that 1935 reached a peak in world consumption of nickel. And nickel being one of the most important alloying elements used in production of machine parts, there is ample proof that designers are becoming more and more "materials conscious."

Sensing this trend, MACHINE DESIGN has for many months been collecting and correlating new data for the purpose of bringing up-to-date its design directories of alloys and plastic materials. The fourth edition of this helpful guide will be published in the March issue.

This coming issue, furthermore, will be devoted exclusively to the application of materials for machine construction. In the exchange of thought and ideas from one machinery field to another should arise a better all-around understanding of this vitally important phase of design work.

Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Computing Velocity Problems

To the Editor:

SOME of the inherent advantages of the phorograph method as a means of studying velocity and force relationships in complicated mechanisms, as compared to the velocity component method or to the time-honored instantaneous center method, have been well brought out by Professor Billings in his article on "Simplifying the Computation of Velocity Problems" in MACHINE DESIGN for December. Other advantages deserve further emphasis.

From the engineering designer's viewpoint, an important advantage is the fact that the phorograph method is inherently somewhat the more powerful of the three. The linear velocity of any point on the mechanism or the angular velocity of any link may be taken off from the same relatively simple diagram.[1] Force relationships and values of mechanical advantage are also indicated. Further, the phorograph method serves as a convenient introduction to studies of acceleration relations, a subject of increasing importance to mechanical designers of the present day, but one which it must be confessed was left as a rather esoteric mystery in the minds of many of our engineering college graduates of not many years past. The acceleration phorograph diagram either gives the desired numerical values directly, or may serve as a basis upon which a mathematical solution can be obtained.

For a number of years I have taught both the phorograph and the instantaneous center method in parallel. Invariably I have found the phorograph method to be more readily grasped by students, and to be accepted as the more easily handled and more easily understood of the two.

Attention might well be directed to two variations of the phorograph method. As ordinarily handled, the reference link in the phorograph diagram is drawn to actual size, to scale. The velocity of any point in the mechanism is then obtainable by measuring the radius from the image of this point, in the phorograph diagram, in to the center of rotation of the reference link, and multiplying by the angular velocity of the reference link in radians (or by $2\pi n$). If a specific solution, in terms of some one angular speed of the reference link, rather than a general solution, is desired, it can be obtained by changing the scale of the reference link in the phorograph diagram so that each radial length will read directly in terms of this velocity. By either of these methods, the direction of motion of the point will be at right angles to the radius in the diagram. If now the further step is taken of turning the phorograph diagram through 90 degrees, it becomes a velocity vector diagram, giving velocities directly, but at the expense of being somewhat more difficult to draw and possibly to visualize. Any one of these three methods may be the most desirable, depending upon the particular problem to be solved.

—M. F. SAYRE,
Union College

[1]See Sayre, "Phorograph Method Simplifies Velocity and Force Calculations," MACHINE DESIGN, Sept., 1934, and "Adapting Phorograph Method to Accelerations," MACHINE DESIGN, Nov., 1934.

Location of Lights Is Important

To the Editor:

SUPPLEMENTARY lighting, as discussed in the article by H. B. Veith in your January issue, may take any of three different forms. The unit may be built into the machine as men-

Ceiling lights such as the one shown are said to provide adequate illumination. They cannot be changed by the operator of the machine

tioned in the article, it may be attached to the machine, or it may be located at or near the ceiling and so directed as to build up the illumination at the point where the severity of the visual task dictates plenty of light. The latter method appears to have some advantages over the other systems, except in the case of small electrically-operated portable machines where there is an obvious advantage in having the lighting unit operated from the same circuit as the machine itself.

Outstanding among these advantages is the fact that the unit is out of reach of the operator. Being out of his reach, the operator cannot change its position as the whim seizes him, nor can he use it as a convenient source of electrical supply for the attachment of some electrical device which he may wish to use temporarily. Operators do this frequently where the lighting unit is accessible, and just as frequently they forget to replace the lamp, particularly if it happens to get knocked off the machine and is broken.

The other day I happened to be in a machine shop where supplementary lighting units were attached directly to the machines. At one of the machines an operator was working on a large hoop and he had adjusted his local light to "help" him see the surface. In its "helpful" position, the lamp was shining directly into his eyes. The operator did not know it, but the glare from the lamp had caused the pupils of his eyes to narrow down automatically, thus restricting the opening for "seeing" light to enter. The result was that 75 to 80 per cent of the usefui light was wasted counteracting the effect of glare. Had the unit been located out of reach of the operator, and properly louvred, this could not have happened.

—Dean M. Warren,
General Electric Co.

Do Engineers Lack Proper Training?

To the Editor:

MY ATTENTION has been attracted by letters in your recent issues commenting upon the training of engineers. It is probable that an educator is the only one who has the opportunity to know of the many demands that are made upon the four short years of an engineering course. Almost everyone agrees that a sound training in fundamentals is the prime consideration, supplemented, perhaps, by a few specialized technical courses to illustrate the practical methods of engineering. College training is, after all, a preparation to solve future problems as they arise, not the solution itself, prepared beforehand.

In spite of this limitation many colleges are creating the trend towards inclusion of more economics and business training in the engineering curriculum. Does Mr. Hazelton (M.D. Jan., p.47) have any reason to believe that business administration and public speaking have not and are not receiving a fair trial in many colleges? My own institution—Case School of Applied Science—offers to seniors a unit of courses in business administration to be substituted for some of the special technical subjects.

Case students may also take a course in effective speaking. Of course, many students graduate without taking any of these courses. Would you require them to take them? I would not say so. All the students going through our mechanical engineering department have to speak to an audience because it is the usual practice in the special technical courses to have each student present a paper; this may result in one student presenting four or more papers to his critical fellows during the year.

My closing comment is most important. Why does everyone seem to think that the college course should prepare one for every occasion that might arise? If a man has devoted himself to securing technical training in college let him plan to extend his training in speaking and business after graduation, when actual need and experience will make him more appreciative of its value. Any young graduate with ambition must soon learn that fact if he is going to progress.

—Prof. E. S. Ault,
Case School of Applied Science

To the Editor:

DO ENGINEERS Lack Proper Training?" And how! I admire engineers—several of them are my best friends. I have done business with and talked to hundreds, high and low, in the course of twenty years' work as a reporter, financial and industrial writer and corporation publicity man. In short, I have had, and am having, frequent contacts with engineers and the fact that I am not an engineer myself may make me a better critic.

I rate engineers highly on their accuracy, thoroughness and ability to work hard. These characteristics they apparently acquire in school and never lose, and engineers are the only group of people who possess them as a class. I admire them to the point that I want my boy to study engineering, and then never work at it.

Besides these things, the graduate engineer gets from college a good grounding in mathematics, a background of science and the knowledge of where to look for the information he needs. He learns his engineering on the job from his associates and his own observation and study.

The engineer's accuracy, thoroughness and

(*Concluded on Page* 76)

MEN of MACHINES

NEW president of the American Standards association is Dana D. Barnum who has served on the board of directors since 1933 when he was elected as a representative of the American Gas association. In his new post he will be in a position to exercise considerable influence on the design of machine parts.

Mr. Barnum was born on August 15, 1872, in Bethel, Conn., and received his formal education at Stevens Institute of Technology from which he was graduated in 1895. Subsequently he took a position with E. W. Bliss & Co., Brooklyn, N. Y., leaving there to join the Worcester Gas Light Co.

In 1917 Mr. Barnum became affiliated with Boston Consolidated Gas Co. The presidency of this organization was accorded him in 1921. He served the A. G. A. as its third president.

DANA D. BARNUM

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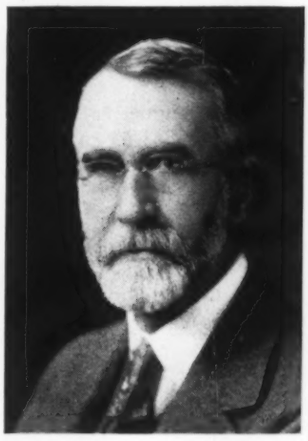


IN DECEMBER the American Society of Mechanical Engineers awarded the A.S.M.E. medal to Charles T. Main, Boston. This distinctive honor was bestowed in recognition of his achievements in industry and education.

A native of Massachusetts, Mr. Main was born at Marblehead, Feb. 16, 1856, and graduated with a B.S. degree in mechanical engineering from M.I.T. where he served as an instructor. In 1879 he entered industry as a draftsman in the Manchester Mills, Manchester, N. H. Two years later Mr. Main became affiliated as engineer with Lower Pacific Mills, and by 1887 was superintendent.

About five years later he decided to return to engineering, and resigned. His consulting work since then has included design and construction of textile mills, steam power plants, etc.

CHARLES T. MAIN

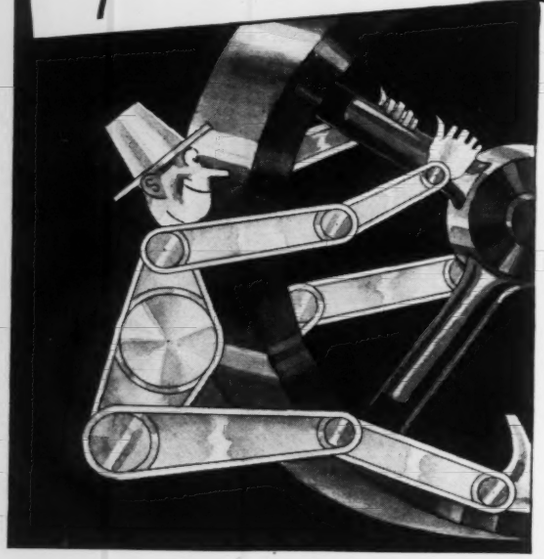
• • •

WHEN Ralph R. Teetor took over the presidency of the Society of Automotive engineers recently he brought with him a background in automotive activity that dates back to 1912. It was in that year he graduated in engineering from the University of Pennsylvania and then became connected with the Teetor-Hartley Motor Co. A division of this organization developed into a piston ring manufacturing company, now known as the Perfect Circle Co. which Mr. Teetor serves as vice president in charge of engineering.

His career with the engineering division of his company has been continuous, except for one year during the World war. In that interval he filled an assignment with the New York Shipbuilding Corp. in Camden, N. J. There Mr. Teetor designed and per-

RALPH R. TEETOR

HE WORKS FOR NOTHING
.. yet he costs you plenty



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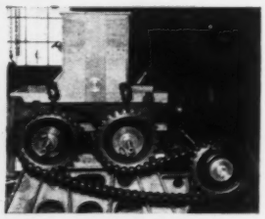

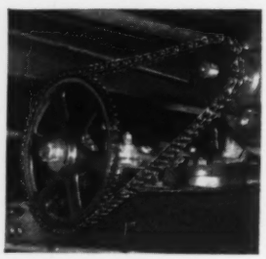

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This superiority is due to ease of lubrication, and to the use of better, more wear-resistant materials, and more efficient design.

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fected a machine to balance high-speed turbine rotors for torpedo boat destroyers. His present capacity brings him in active contact with the design of machinery for research and manufacturing facilities.

♦ ♦ ♦

RALPH U. BLASINGAME, professor of agricultural engineering, Pennsylvania State college, has been nominated for president of the American Society of Agricultural Engineers.

♦ ♦ ♦

CHARLES F. KETTERING, vice president in charge of research for General Motors Corp., recently received the Washington award for 1936. For picture and biographical sketch of Mr. Kettering see the June, 1930, issue.

♦ ♦ ♦

COL. E. A. DEEDS has been made chairman of the board of National Cash Register Co., Dayton, O. He was one of the projectors of the Dayton Engineering Laboratories Co. in association with Charles F. Kettering, this company later becoming the Delco Light Co.

♦ ♦ ♦

JAMES L. WICK, president and general manager of Falcon Bronze Co., Youngstown, O., recently was nominated for president of the American Foundrymen's association for the years 1936-37. A picture and brief biographical sketch of Mr. Wick appeared in the December issue of MACHINE DESIGN.

♦ ♦ ♦

VINCENT DELPORT, director and manager of the Penton Publishing Co. Ltd., London, European subsidiary of the American company, has been elected vice chairman of the International Committee of Foundry Technical associations. He is the European representative of the American Foundrymen's association.

♦ ♦ ♦

WALTER E. HOLLAND, vice president of engineering of the Philadelphia Storage Battery Co., has resigned as an officer and director of Philco and is retiring from active business. Prior to his connection with Philco eighteen years ago, he was chief engineer of the Edison Storage Battery Co. and spent ten years in close association with Thomas A. Edison.

Obituaries

GEORGE CAMERON STONE, internationally known metallurgist, as well as one of the organizers and chairman of the American Engineering Standards committee (now the American Standards association) died recently in his seventy-ninth year. He was associated with the New Jersey Zinc Co. from 1882 to 1929 when he retired, having served as chief metallurgist. Important patents held by him included two for the manufacture of sulphuric acid, two on gas filtration and separation, one each on zinc and lead extraction from ores, and the others covering a new form of jig, a gas producer and flotation apparatus.

♦ ♦ ♦

BRYCE E. MORROW, former employe and personal friend of Thomas A. Edison, died recently at his home in Jackson, Mich. He was sixty-three and at the time of his death was chief engineer and manager of the production and transmission department of Consumers Power Co.

♦ ♦ ♦

HARRY L. HORNING, president and founder of the Waukesha Motor Co., died recently at Battle Creek, Mich., at the age of fifty-five. He was past president and honorary life member of the Society of Automotive Engineers.

M-R-C Ball Bearings

An M-R-C Ball Bearing

An M-R-C Ball Bearing

An M-R-C Ball Bearing

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Combining the engineering and manufacturing experience of three pioneer ball bearing manufacturers—Gurney, SRB and Strom—the Marlin-Rockwell Corporation presents an organization trained and equipped to render a complete service to users of high quality ball bearings.

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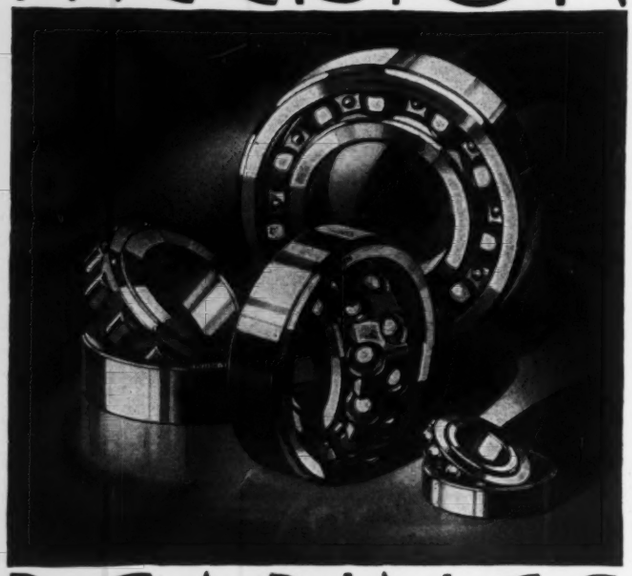

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PRECISION—as the term defining the characteristics distinctive of NORMA-HOFFMANN Bearings—comprehends ALL those qualities which reveal themselves in higher anti-friction efficiency, greater speed-ability, better performance, longer life, fewer replacements, improved production. ✲ ✲ ✲ These are the definite and tangible gains which accrue to the builder and user of any machine in which NORMA-HOFFMANN PRECISION Bearings are incorporated. ✲ ✲ ✲ Write for the PRECISION Bearing Catalogs. ✲ ✲ ✲ Let our engineers work with you—without obligation.

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PRECISION BEARINGS
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Noteworthy Patents

USE of a relatively high vacuum has been found to give beneficial canning results particularly with some products of a cellular nature, such as fresh fruits. The American Can Co., New York, is assigned a new patent that protects the cans while this is being carried out. John M. Young is the inventor.

By holding a sufficient part of the exterior the can walls during vacuumization, pressure of the surrounding atmosphere cannot substantially distort or change the shape of the container. The filled can *A* is positioned and clamped as depicted in *Fig.* 1, *X*, ready for the vacuumizing operation. Lever *B* of a three-way valve is then

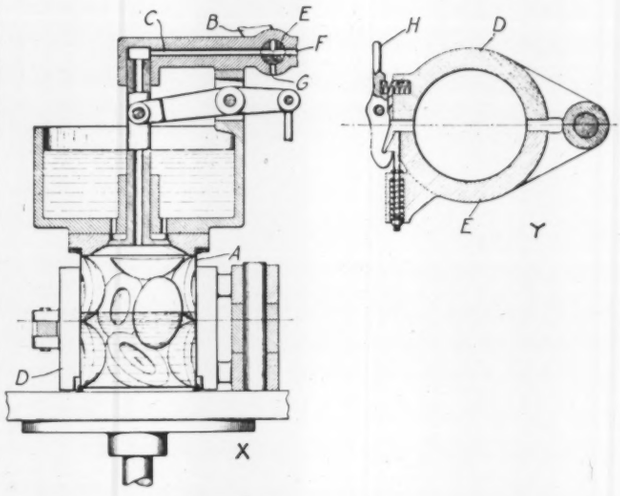
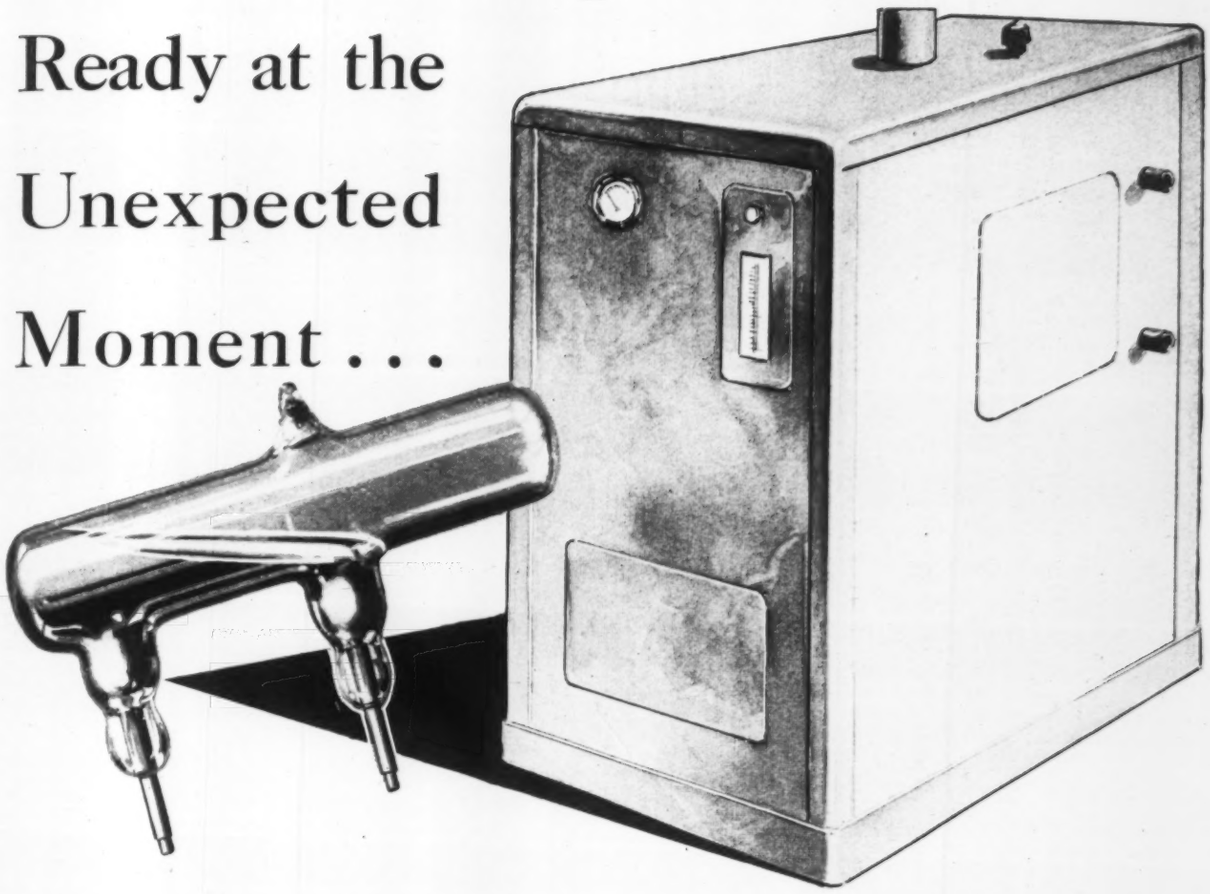


Fig. 1—*Container is protected during vacuumization by this equipment for preventing collapse of sides*

Ready at the Unexpected Moment . . .



KON-NEC-TORS

(Mercury-to-Mercury Switches)

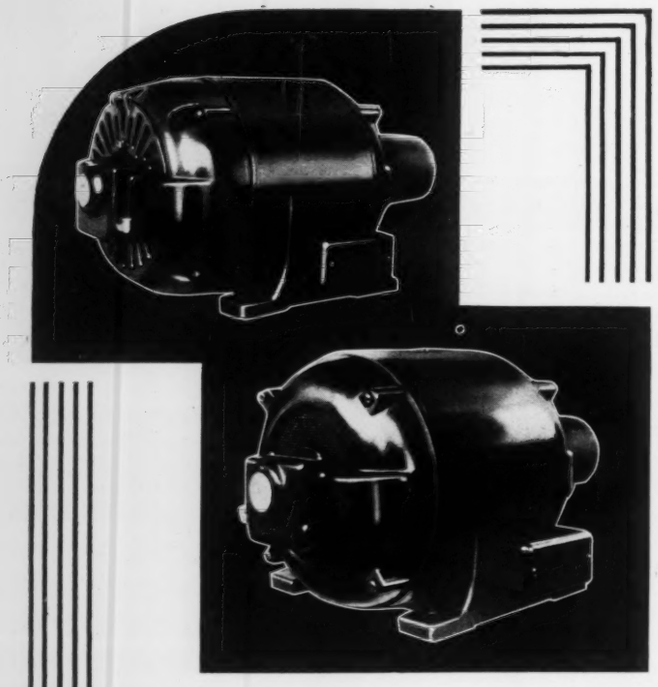
The ability to perform promptly and satisfactorily at any unexpected moment, even though that moment should occur only once in several years, is one reason why a prominent oil burner manufacturer uses KON-NEC-TOR Switches. The master control system of this oil burner incorporates two mercury-to-mercury switches. One is activated by the thermostat and operates each time the burner goes on or off; the other stands by throughout the life of the burner, ready to safeguard it against emergency.

Clean contacts at all times are assured as KON-NEC-TORS never become corroded or covered with soot. There are no contact points or springs to cause frequent trouble. Year after year these sealed-in mercury switches are giving this manufacturer quiet, trouble-proof and maintenance-free operation.

Other equipment builders find that the elimination of arcing troubles with KON-NEC-TORS, the negligible amount of energy required to operate them, their safety in explosive atmosphere, and their quick replaceability as a unit make them the ideal switch. And their use frequently reduces manufacturing costs. Send for complete details . . . General Electric Vapor Lamp Company, 825 Adams Street, Hoboken, New Jersey.

GENERAL ELECTRIC VAPOR LAMP COMPANY

679



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operated to connect passageway *C* with the source of vacuum *F* by means of a passageway in the valve, this position being shown in drawing *X*. Air thereupon is withdrawn from the interior of the can where a high vacuum is established.

The can, not being in a vacuum chamber, is subjected to atmospheric pressure that tends to crush the wall inwardly. This action is obviated by jaws *D* and *E*, shown in drawing *Y*, which do not allow the can wall to move out of its original shape. After the can has been vacuumized and filled, valve *E* may be shifted to cut off communication with the source of vacuum *F* and connected with passageway *G* leading to the outside of the valve casing. Air then enters and breaks the vacuum on the interior of the can. When the operation is completed the can is readily removed by disconnecting a catch member by manual pressure on handle *H*. Number 2,026,602 identifies the patent.

AN INDEXING device that will effect partial rotation of a reciprocating piston rod in one direction and a subsequent rotary movement in the opposite direction, is the basis for a patent recently granted to Easy Washing Machine Corp. Cam *A*, *Fig.* 2, drawing *X*, is of such shape that as the parts are raised to the position shown by the dotted lines, the cam face will not have effected any movement of the bell-crank *E* so that bevel gear segment *F* will have remained at rest. Thus the vacuum cups *K* mounted on pistons *G* of the washer will be raised directly upward through the water and will not be carried circumferentially of the vat until they have passed above the water level.

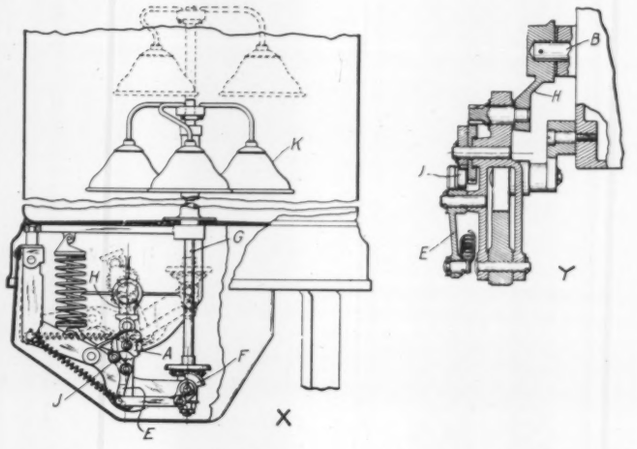

Fig. 2—Vacuum cups of washer are indexed so that they will contact with different parts of a batch of clothes

As the crank *H* which is driven by shaft *B* (drawing *Y*), continues to carry the parts up-

WATCH COSTS COME DOWN

- - - *when the steel is right!*

TAKE these two gears, for instance. One was the despair of the machine shop. "The toughest gear to cut I ever saw," said the superintendent. Tool life was so short that 25% of the machining time was spent changing tools. And the gears were noisy, wore badly.

The other is the same gear, but made of different steel-S. A. E. 4615. With this new steel, machining is simple. There's no peeling of the tool. Gear teeth finish is smooth and uniform. Gears operate quietly — last longer. And production is up. Costs are down.

• • •

Be fussy about the steel you use. A simple change in specifications may give you the answer to problems that vitally affect your costs.

A wide range of modern, *dependable* alloys are here to keep costs down and quality up—to add strength without increasing size or weight . . . to reduce machining costs without a single change in equipment...to eliminate re-heating.

Dependable **ALLOY STEELS**

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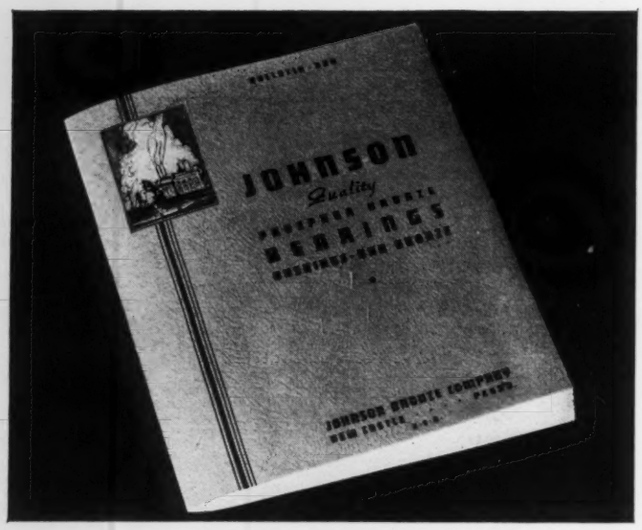
Export Distributors—United States Steel Products Co., New York.

US STEEL

UNITED STATES STEEL



YOUR *Guide* TO
GREATER
BEARING PERFORMANCE

● There's a copy of the 1936 Edition of Bulletin 360 waiting for you. It contains a world of helpful information concerning Bearing Bronze—and will prove of service many times during the coming year.

For instance, Johnson UNIVERSAL Bronze Bars—completely machined—are now available in 187 sizes of Cored and 33 sizes of Solid. Many new sizes have been added to the General Purpose Bushings list and each individual Electric Motor Service Bearing is illustrated—so that you can be absolutely certain in the selection of your requirements.

Leading Industrial Supply Distributors everywhere carry complete stocks to give you immediate service. Write today for your copy and the location of your nearest source of supply. There is no obligation.

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wardly, roller follower *J* will have moved on cam *A*, and during this movement the cam will have caused bellcrank *E* to move about its pivot to rock the bevel gear segment arm. Through the segment gear *F* and bevel gear this movement causes a partial rotation of piston *G*, carrying the vacuum cups approximately 30 degrees circumferentially of the vat. As the operation continues and roller *J* follows the concave face of the cam *A*, the bellcrank will rock the bevel gear segment in the opposite direction. No rotary movement of the piston takes place during its downward travel. Patent number identifying this mechanism is 2,010,784.

FLEXIBLE connection between two rotating members of a coupling is obtained by employing a double strand roller chain in a newly patented device depicted in *Fig.* 3. One of the objects of this construction is to provide a sim-

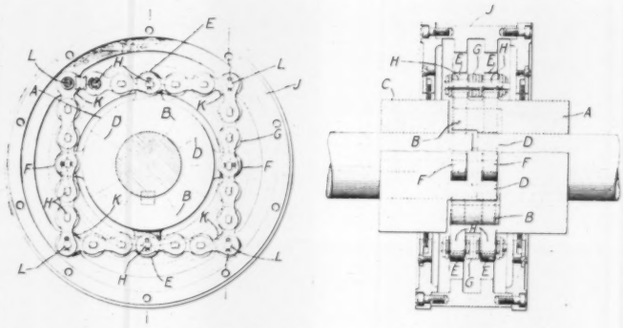

Fig. 3—*A strand of roller chain provides a flexible connection between the two members of a coupling*

ple, strong and effective coupling permitting a certain amount of parallel and angular misalignment, but having no appreciable backlash. Member *A* has a pair of jaws *B* spaced 180 degrees apart; likewise *C* has similar jaws *D*, the jaws of one member fitting the spaces between the jaws of the other. Jaws *B* of member *A* are provided with lugs *E*, and jaws *D* with similar lugs, spaced to accommodate the double strand of roller chain.

As can be seen from *Fig.* 3, these lugs are provided with apertures designed to receive pintles *H*. A ring J is located between coupling members *A* and *C* and has four sets of internal lugs *K* which receive the chain in the same manner as lugs *E* and *F*. The chain is secured to the lugs of the ring *J* and coupling members in the form of a rectangle, pintles *L* at the lugs of the ring being of the plain round type to permit right angle bending of the chain.

According to David B. Perry, the inventor of the device, parallel or angular misalignment is taken care of with a minimum amount of backlash. He points out that in a coupling of, for

MOLY increases the pay load by decreasing the dead load

FREIGHT haulage is the railroad's "bread and butter." One way to lower operating costs is through lighter, yet stronger, load-carrying rolling stock. It permits larger pay loads per car or more cars per train; less strain (particularly in starting) and less fuel consumption.

"Moly" steels have an important bearing on this pay-load/tare-load ratio. They are stronger per unit section, and are readily welded—permitting lighter construction. Frames and bodies can be made lighter, wheels stronger and more wear resisting, by using Moly steels.

"A little Moly does a lot," therefore Moly steels cost less than other alloy steels having equivalent properties for a given purpose. They cost but slightly more at first than plain carbon steels, and cost much less in the long run.

That is not the whole story by any means. Moly steels reduce wear, breakage, and destruction from corrosion. Consequently, maintenance and depreciation costs are reduced. Summed up, Moly steels will make a notable reduction in over-all operating costs, on a train-mile or any other basis.

Innumerable instances prove Moly's worth. Our book, "Molybdenum," gives valuable technical data. Yours for the asking—as is also "The Moly Matrix," our periodical news-sheet. Climax Molybdenum Company, 500 Fifth Avenue, New York.

CUTS COSTS CLIMAX Mo-lyb-den-um CREATES SALES

MOLY

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Get a motor that's five-time inspected.

2
Insist on a dynamically balanced armature.

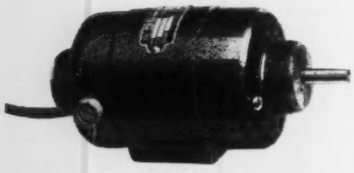
3
Make sure that motor is "run-in" to seat brushes.

4
See that commutator leads are swedged securely—the Dumore way.

5
See that motor has forced ventilation.

6
Make sure commutator is ground concentric with bearings.

7
Demand armature windings sealed against centrifugal "breathing".



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example, eleven inches in outside diameter, in which the length of each strand of chain is approximately six inches, a quarter-inch displacement of one of the shafts in relation to the other, requires a slack in the chain of only approximately .011 inch, which would result in little or no backlash between the two shafts.

Morse Chain Co., Ithaca, N. Y., is assignee of the patent designated No. 2,024,473.

A FOOTAGE indicator which apprizes the operator of a motion picture camera through the sense of touch, of the number of feet of film that has been consumed, is covered in a new patent assigned to Eastman Kodak Co. The feelable member of the invention is button *A*, *Fig.* 4, attached to flexible covering *B* of the camera. Pinion gear *C* of the operating mechanism, is provided with an annular recess in which is located a rivet *D*.

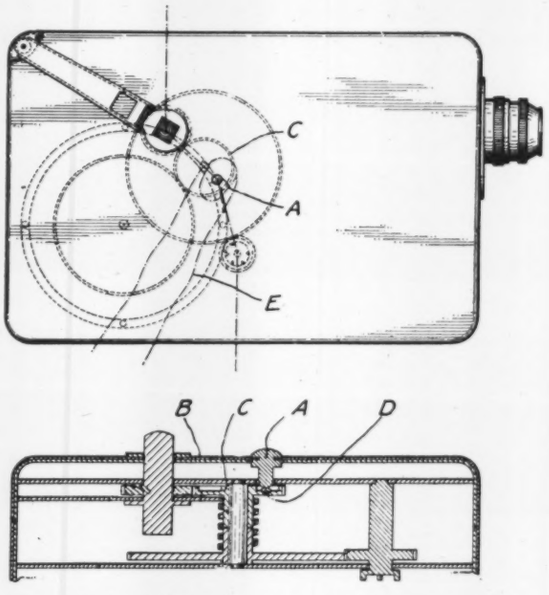
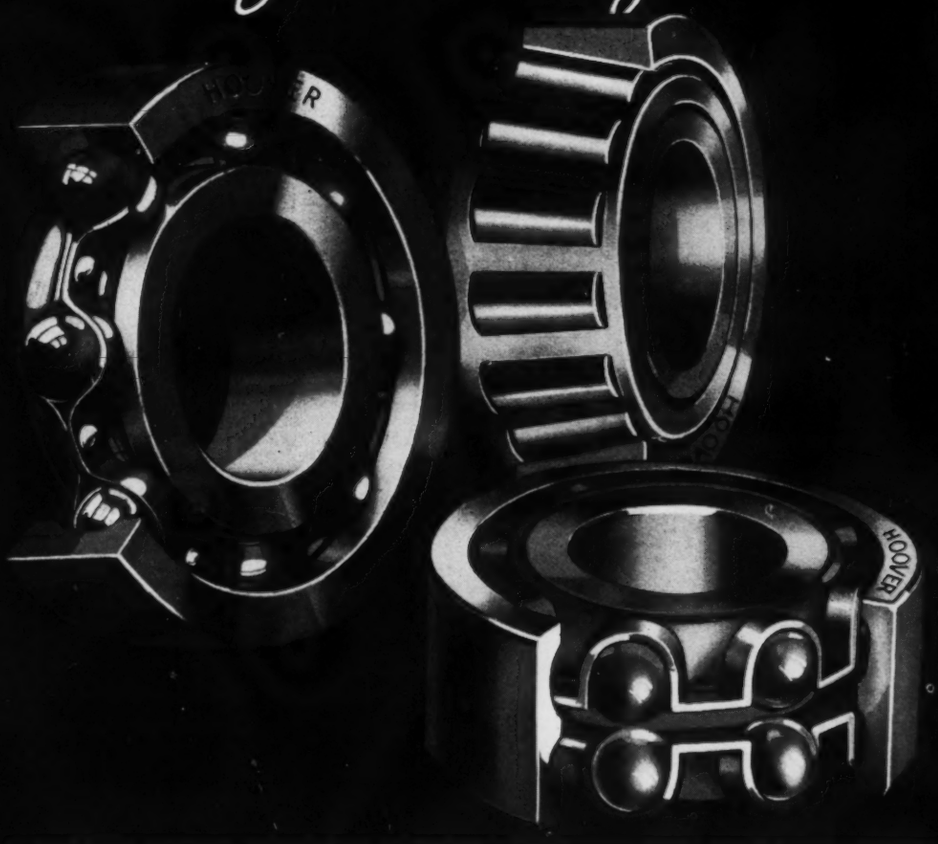


Fig. 4—Film footage indicator employs a pulsating button that utilizes the operator's sense of touch

When the camera is in operation pinion gear *C* rotates, causing rivet *D* to engage the end of button *A* which consequently is pulsated periodically. Since each rotation of the gear bears a definite timed relation to the rate of film advancement through the apparatus, each impulse imparted to the button will indicate to the operator whose finger *E* rests on the button, that a certain number of feet has been used. In other words, the timing of the driving means is such that pinion *C* rotates twice for each foot of film advancement; therefore each pulsation indicates that half a foot of film has passed through the camera.

Otto Wittel was granted the patent designated No. 2,027,007.

The ARISTOCRAT of Bearings



During 1935 there were 5,470,000 HOOVER BALL and TAPERED ROLLER BEARINGS furnished to the Machine Tool, Electrical, Automotive and Industrial Fields.

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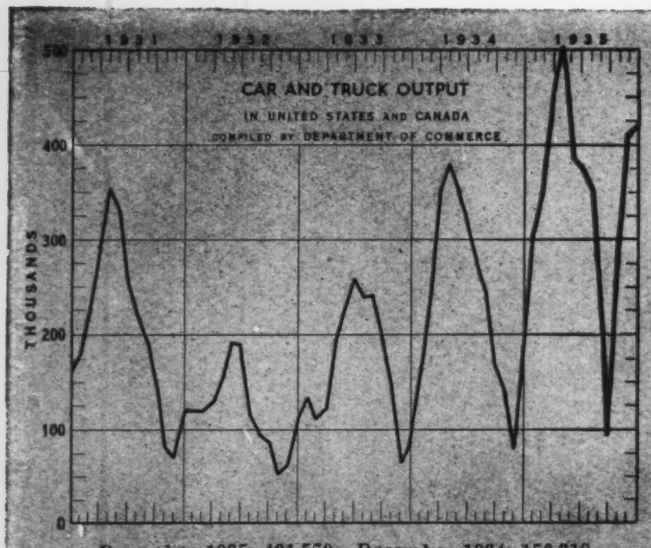
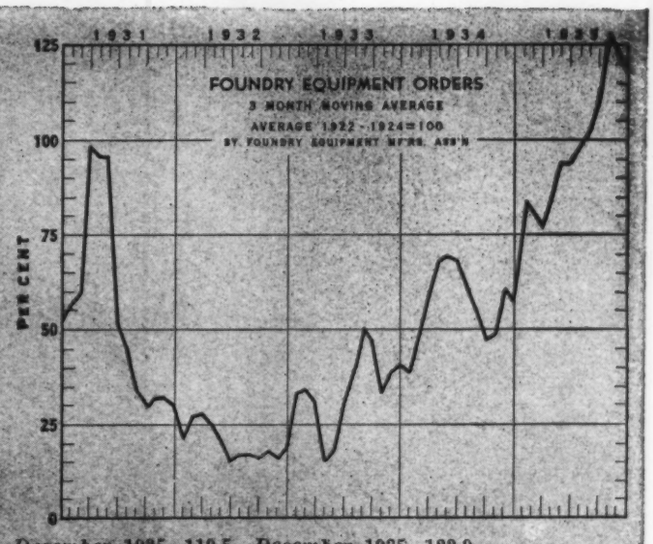
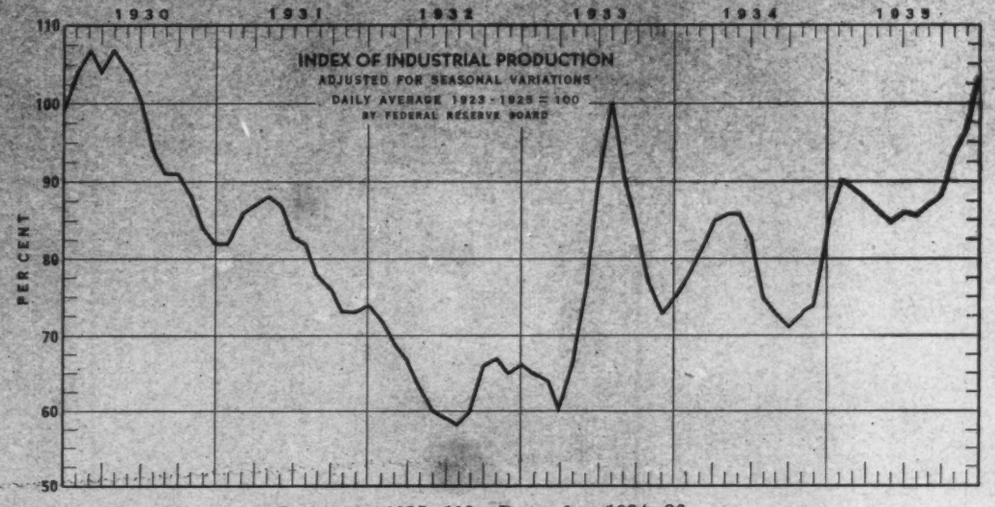


December 1935, 421,579—*December* 1934, 156,318

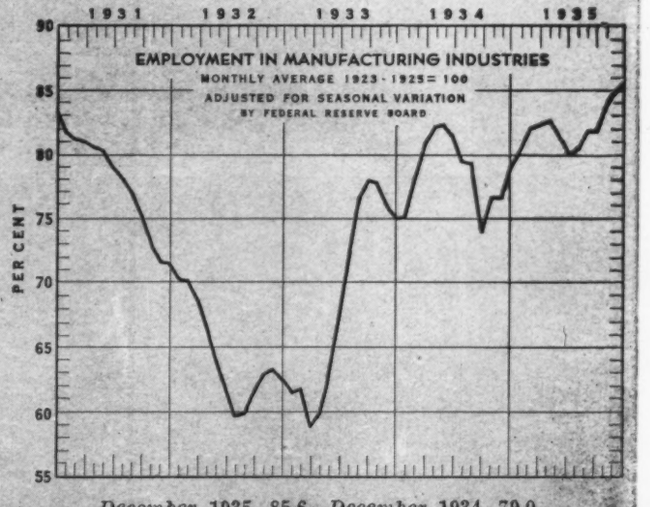


December 1935, 119.5—*December* 1935, 122.9



December 1935, 103—*December* 1934, 86

December 1935, 99.9—*December* 1934, 54.1



December 1935, 85.6—*December* 1934, 79.0

MATERIALS

will be featured in the March issue of

MACHINE DESIGN

● Design success depends upon the materials employed. Selection of material is vitally important, and is complicated by the many types available. To aid in making this selection, the next issue of Machine Design will include editorial discussions on the following:

DIRECTORY... Alloys, plastics and other non-metallic materials used in machinery will be classified in a complete directory to aid the chief engineer and designer in the precise selection needed for good design.

DESIGN OF MACHINERY... Noteworthy advancements considered from the materials standpoint.

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STAINLESS STEELS... Advanced applications illustrating the advantages afforded by latest developments.

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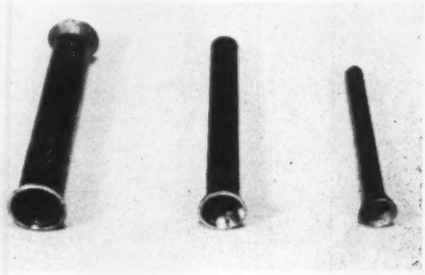
NEW *Materials and Parts*

Steel Tubing in OD Sizes

SEAMLESS steel tubing for service lines in industrial and commercial refrigeration and air conditioning units, oil lines and feed lines in hydraulic feed machines and similar uses is being produced by Summerill Tubing Co., Bridgeport, Pa. This tubing, which has a ductility



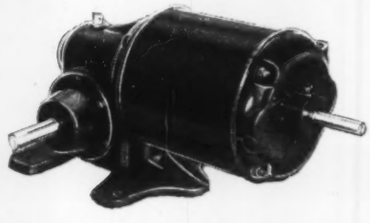
Steel tubing can be bent and thrashed for standard SAE fittings

approaching that of copper so that it can be bent and thrashed for standard SAE fittings, is furnished in OD sizes, the same as copper, and eliminates the necessity of reverting to pipe sizes and threaded pipe fittings when ammonia must be handled.

In the manufacture of seamless steel tubing for these applications, a special low carbon analysis is selected, both for its properties of ductility and its resistance to corrosion. A characteristic of the tubing is that it is free from any oxide or scale.

Many Drive Styles Are Developed

TO SATISFY applications which require power delivered at any specified speed, Wagner Electric Corp., St. Louis, has developed



Fractional horsepower gearmotors are suitable for direct connection to the equipment being driven

fractional horsepower gear motors that are suitable for direct connection to stokers, agitators, conveyors, low-speed pumps, mixers, or similar machinery. The units are available in single

Add Profit

TO YOUR PRODUCT WITH THESE MOTOR ADVANTAGES

Correct motor application in machine design involves three factors: (1) The motor must be able to do all that is expected of it . . . and sometimes more, (2) Its design must insure economical application, (3) Its appearance must add to the salability of the product.

Wherever Single Phase Motors are indicated, Century Repulsion-start Induction Brush-lifting Type Motors combine all of these important advantages. • • Sizes 1/8 to 40 Horse Power.

Other Types of Single Phase, Polyphase and Direct Current Motors available up to 600 Horse Power.

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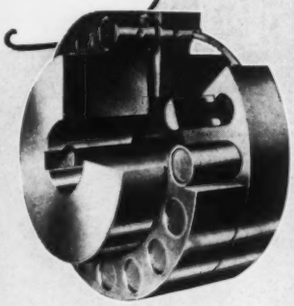

The FRANCKE design provides low initial cost and concentration of wear in a few component parts which can be quickly replaced without disturbing connected machine. Machine buyers know FRANCKE as an eminently satisfactory coupling on drives subject to shock load or vibration.

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Page 7—MACHINE DESIGN

Do you want new ideas on bearing applications? *See Page 7!*

Are you selecting a material for your machine? *See Page 7!*

Have you *any* design problem on which you would like assistance? *See Page 7!*

In every issue of MACHINE DESIGN the problems, parts, materials, mechanisms, in short, every detail covered by that issue is carefully *Itemized* for ready reference when considering a specific problem. The contents for each year is Itemized in the Annual Index.

Increasing reference is being made to this Itemized Index by alert engineers as a regular part of their design procedure.

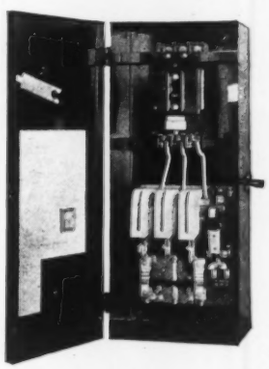
SEE PAGE 7!

reduction and double reduction types, with right angle-shaft drive; and in single reduction, double reduction and triple reduction types with parallel shaft drives. They are available for delivering power at speeds as low as 6 RPM. The accompanying illustration shows a typical single reduction, right-angle drive gear motor having an output speed of 30 RPM, driven by a 1/6-horsepower, 110/220 volt, 60 cycle, 1725 RPM motor of the ball bearing, single phase, repulsion-start-induction type with special high-speed shaft extension. The gearcase incorporates a phosphor bronze worm gear driven by a heat-treated nickel alloy steel worm. The low-speed output shaft is supported on two roller bearings.

Introduces Improved Magnetic Switch

COMBINATION magnetic switches with maximum ratings of 25 horsepower at 220 volts and 50 horsepower at 440 to 600 volts have been introduced by General Electric Co., Schenectady, N. Y. This new line parallels, but does not supersede, a line of similar ratings incorporating a magnetic switch with overload relays for motor running protection.

In these new switches, shown herewith, air

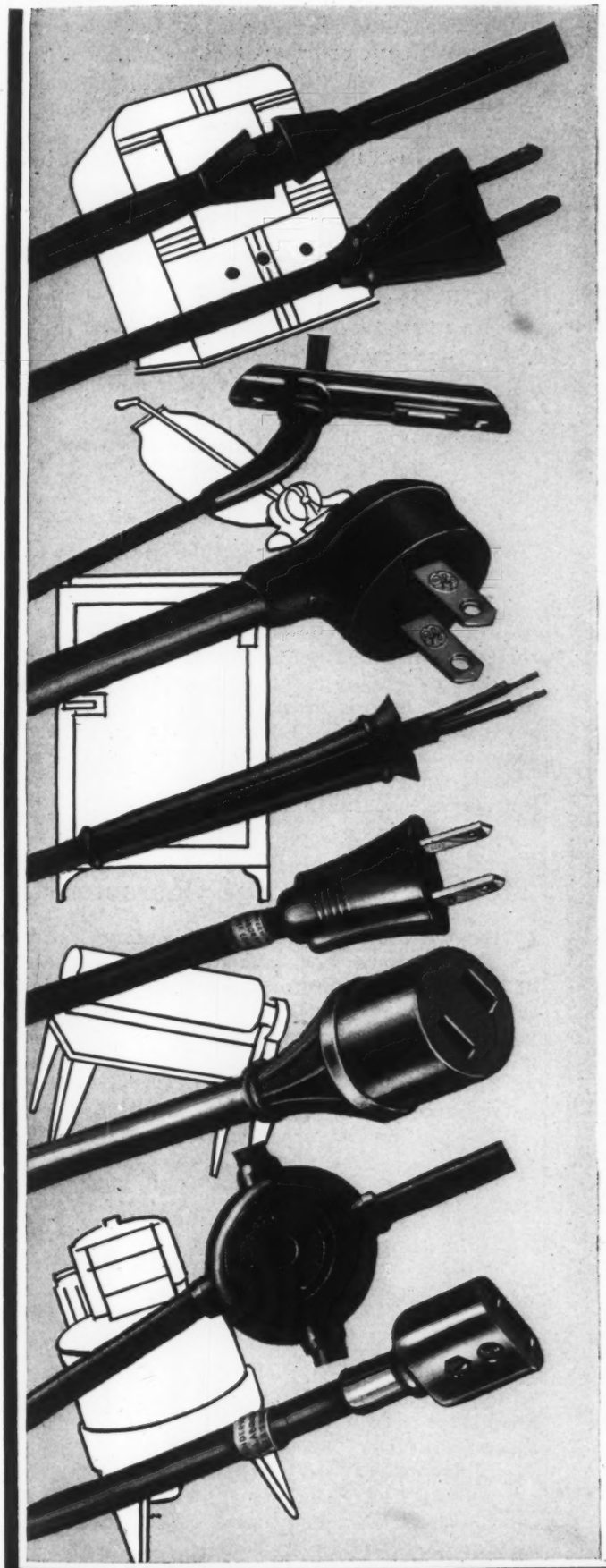


Air circuit breakers which can be reset by hand are employed in new combination magnetic switches

circuit breakers which can be reset by hand after tripping are used instead of fused safety switches. The breaker operating handle is interlocked with the enclosing case door so that it cannot be opened when the breaker is closed and the breaker can be locked either open or closed from the outside of the case.

Unit Base Isolates Machinery

A NEW type of machinery base, known as type T Seismo-Damper, in which strength, compactness and vibration isolation for medium and light machinery are combined has been introduced by Korfund Co. Inc., 48-15 Thirty-second place, Long Island City, N. Y. With the



PROTECT

YOUR APPLIANCES WITH G-E MOULDED RUBBER DEVICES

Just as a chain is as strong as its weakest link — just as a train is as strong as the coupling between cars — so an electrical appliance is as strong as its cord set and electrical connections.

By using General Electric moulded plugs, moulded rubber strain reliefs and moulded rubber delta connections, the true-value and worth of your appliances are protected. All G-E moulded rubber devices are moulded onto the cord in one piece, not simply attached. They will outlive their cords.

Investigate the line of G-E All-rubber devices — moulded on the cords. All types of rubber plugs, strain reliefs, connectors, angle caps and delta connections are available. They meet all tests and requirements of the Underwriters' Laboratories. Best of all, they assure consumer satisfaction and freedom from service charges.

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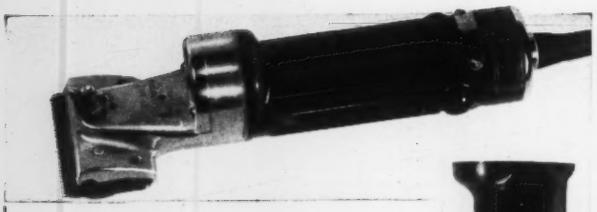

ELECTRO-MECHANICAL PARTS OF MOLDED PLASTICS

The Chicago Flexible Shaft Company's Electric "Clipmaster" parts, are molded of impact Bakelite, to provide extra strength, lightness, and electrical and heat insulating qualities. The motor housing proper, which also serves as the handle, is always cool, comfortable and safe. Absolute accuracy and uniformity of all molded parts were required to permit complete interchangeability and easy assembly.

This exacting molding job is only one of many which Chicago Flexible Shaft Company have entrusted to this organization. Like many other nationally known firms, they have found here intelligent appreciation of their problems, plus the necessary design and production facilities to give them exactly what they want when they want it.

Perhaps we can assist you in the solution of your problems. You are invited to consult us without obligation.

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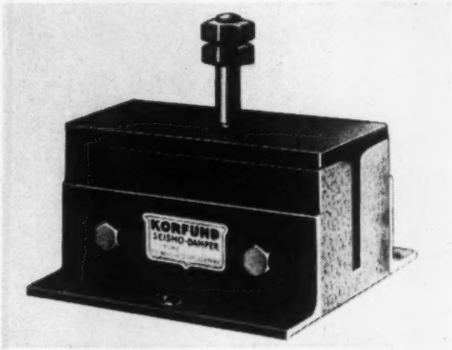
unit, the machine is directly supported by a T-iron separated from a base of two angle irons by natural cork or other isolating material. The angle irons are connected by bolts passing through the isolating materials and T-iron, but not touching it.

Before installation these bolts are adjusted

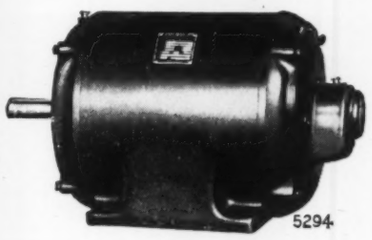


Natural cork or other isolating material is employed in machinery base

to produce a precompression of the isolating material to suit the machine load. Further adjustment can be made after installation. Where the machine frame is light or must be supported at several points, the T-iron can be extended to form a continuous support between two or more Seismo-Dampers. This eliminates undue bending stresses in the machine frame.

Motors Have Unique Characteristics

SINGLE-PHASE motors with a smooth torque-speed curve, the efficient starting features of the repulsion motor, and the approximately constant speed load operation of the induction motor have been brought out by Emerson Electric Mfg. Co., St. Louis, as the type SR motor. At the present time, 1725 RPM motors have been developed in 1, 1½, 2 and 3 horsepower



Improved motors are designed to secure the efficient starting features of the repulsion type

sizes. The SR motor has an armature with both a squirrel-cage winding and a repulsion or commuted winding. Both windings operate as such at all times; the commutator of the repulsion winding is not short circuited as the motor attains speed and the squirrel cage is not opened at slow or starting speeds.

As there is no heavy sparking with resultant

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The last word in planning and engineering: correct drawings and prints, the best materials, the utmost in experience, supervision and mechanical facilities—all this would be lost if Murph didn't look 'em over. • We are all "Murphs" at the D. O. James Manufacturing Company—constantly on our toes, watching for any error in design and construction in the production of worm gears and worm gear reducers.

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All mechanics use their fingers driving Screws. Knurls gear fingers to head; fingers, therefore, have better purchase, drive faster and further.

Pliers bite the Knurled "Unbrako," but slip on Smooth-Heads.

Ask how we lock the Knurled "Unbrako" when countersunk—it's unique.

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U. S. & Foreign Pats. Pending

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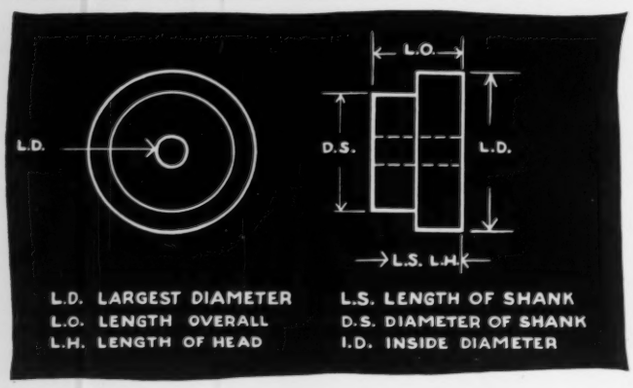

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pitting of the commutator and as the starting action is smooth and steady, the motor is especially suited for starting and bringing to speed sustained heavy starting loads, such as an air compressor at low temperatures which congeal the oil. The SR motor maintains its initial starting torque throughout making it suited for application on commercial refrigerators, pumps, grinders, choppers, mixers and other devices which may offer a heavy starting load or in which starting is prolonged because of excessive friction.

Announces Small Capacity Pumps

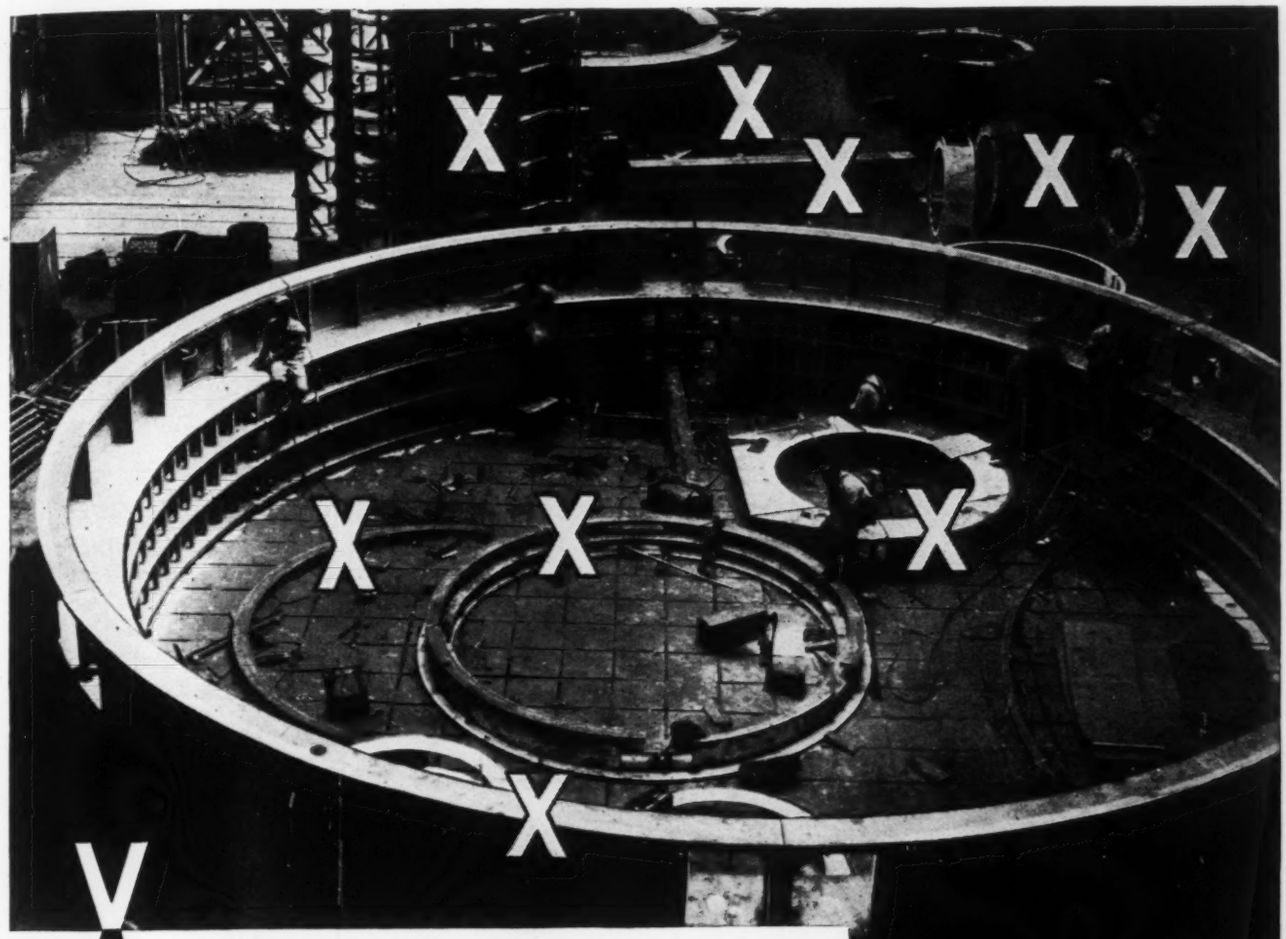
FOUR gallon per minute pumps are now being manufactured for both low and high pressure service by Acme Machine Products Co. Inc., Muncie, Ind. The low pressure pump is equipped with a ⅛-horsepower motor and the high pressure type with a 1/3-horsepower motor. An adaptor base for side wall mounting is available. This new model, shown herewith, completes the range of pumps from 4 to 100 gallons per minute as manufactured by the company. It is adaptable where only a limited amount of coolant is desired, such as lathes or other single spindle machine tools.

Low pressure pumps are adaptable where only a limited amount of coolant is required

Control Device Prevents Burnouts

FUNCTIONING as a manually operable switch with automatic current overload protection, a compact and simple combination control device known as the Colt-Noark "Protectit" is a recent innovation of Colt's Patent Fire Arms Mfg. Co., Hartford, Conn. The unit, shown herewith, is adapted for mounting on the cover plate of an outlet box or directly on a wall or a machine. Special casings can be supplied. The casing shown is only 3⅛ inches long, 1½ inches wide and 1½ inches deep.

The control has a maximum voltage rating of 250 volts alternating or direct current in any of



X MARKS THE SPOT!

. . . where welded Rolled Steel gives greater strength with less weight . . . at lower cost.

WE do not claim that Rolled Steel, flame-cut and arc-welded, can be applied economically to *all* machine construction. But we do know this: that in an amazing number of applications this modern manufacturing process has demonstrated its ability to produce a higher-quality job, at lower cost, than any method hitherto employed.

In building heavy machinery and special equipment this is particularly true. Here, the adaptability of rolled steel construction offers the machine designer an ever-widening field of use. For with rolled steel he deals with a material of known strength. He can discard all excess weight and bulk—place his stiffening and wearing members where he wants them. He can simplify and improve appearance—quickly and inexpensively alter design if necessary. At the same time inventory can be reduced—production costs drastically lowered—the time from drawing board to finished job speeded up—quicker deliveries made possible.

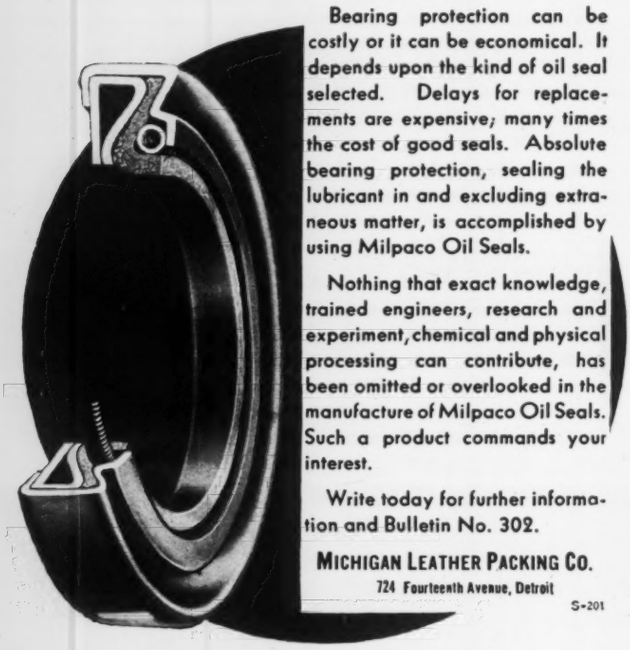
THIS BOOK IS YOURS

Prepared by practical men — to answer your questions about Rolled Steel. Tells how weight is affected . . . what savings are possible . . . what types of steel are best suited . . . includes suggestions on economies in buying . . . explains modern shop technique. Send for your copy today.

CARNEGIE-ILLINOIS STEEL CORPORATION - *Pittsburgh, Chicago*
COLUMBIA STEEL COMPANY - - - - - *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY - *Birmingham*

UNITED STATES STEEL

MILPACO



Bearing protection can be costly or it can be economical. It depends upon the kind of oil seal selected. Delays for replacements are expensive; many times the cost of good seals. Absolute bearing protection, sealing the lubricant in and excluding extraneous matter, is accomplished by using Milpaco Oil Seals.

Nothing that exact knowledge, trained engineers, research and experiment, chemical and physical processing can contribute, has been omitted or overlooked in the manufacture of Milpaco Oil Seals. Such a product commands your interest.

Write today for further information and Bulletin No. 302.

MICHIGAN LEATHER PACKING CO.
724 Fourteenth Avenue, Detroit

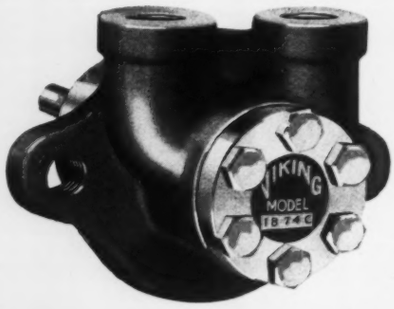
S-201

1911 25th ANNIVERSARY 1936

OIL SEALS

25 YEARS - *Time Tested*

Every Viking Pump features Viking's original "Gear Within A Gear — Two Moving Parts, principle — tested over a period of a quarter century in 500,000 Viking units.



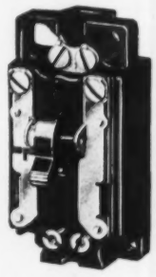
VIKING ROTARY PUMPS

25 YEARS OF DISTINGUISHED SERVICE 1911 1936 VIKING ROTARY PUMPS

The pump illustrated above is ideally adapted for all types of machine application. Convenient for direct mounting—for either pressure or vacuum service. Capacities from 18 to 190 G.P.H. at 100 lbs. Write for Special Bulletin and Prices.

Viking Pump Company
Cedar Falls, Iowa

its ampere ratings. Its maximum rating is one horsepower. The operating mechanism of this device includes a bimetallic strip, serving as a mechanical latch, which connects the switching member and its movable contacts with the handle. Overheating of the strip by the passage of



Adapted for mounting directly on a machine, control device functions as a manually operable switch with overload protection

an electrical overload through it causes it to bend sufficiently to release the switching member, thereby breaking the circuit. The unit, though entirely "handle free," embodies automatic "handle return."

Two types of "Protectits" are available, type "BH" which makes use of interchangeable heater elements and type "B" which has a fixed ampere rating and cannot be changed. Nineteen differently rated heater elements, ranging from 1.3 to 14.2 amperes are available for use with type "BH." Ten type "B" units with fixed ratings are now listed, ranging from 1.3 to 15.0 amperes.

Small Motors Are Backgeared

FRACTIONAL horsepower motors with backgear reduction in the new type GE have been announced by Signal Electric Mfg. Co., Menominee, Mich., manufacturer of small motors. Available in 1/45 to 1/30 horsepower, this motor is 4-pole alternating current con-

An unusually high starting torque is provided with fractional horsepower motors with backgear reduction

struction for long hour service. The copper shade for starting eliminates the usual centrifugal switch, condenser or brush and commutator. A higher starting torgue than is usually found in motors of this type is developed in the new motor shown herewith. The units can also be furnished in 4-pole series wound

FORMICA SILENCES HEAVY DRIVES!

HEAVY as well as light drives may be silenced and improved by the insertion of an elastic member if large Formica gears are used for the purpose.

Metal to metal contacts sometimes result in a grind and screech that is very unpleasant and which exhausts the nerves of the workmen and results in less efficiency and poorer work.

More and more manufacturers are using Formica gears to provide an important sales point for their sales departments. More and more maintenance engineers are using Formica because it keeps things running smoothly and sweetly.

The gear cutters named can give you prompt service on one or many gears.

THE FORMICA INSULATION COMPANY • 4640 SPRING GROVE AVE., CINCINNATI, O.

FORMICA Gear Cutters

•

The Akron Gear & En'g Co.
Akron, Ohio

Farrel-Birmingham Co., Inc., Buffalo, N. Y.

Slaysman & Company
Baltimore, Md.

Harry A. Moore
Bangor, Me.

The Union Gear & Mch. Co.
Boston, Mass.

The Atlantic Gear Works
New York City

Chicago Rawhide Mfg. Co.
Chicago, Ill.

Perfection Gear Company
Chicago, Ill.

The Mechanical Specialty Mfg. Co., Chicago, Ill.

Merkle-Korff Gear Co.
Chicago, Ill.

Chicago Gear Company
Chicago, Ill.

The Cincinnati Gear Co.
Cincinnati, O.

The Horsburgh & Scott Co.
Cleveland, O.

The Stahl Gear & Machine Co., Cleveland, O.

The Master Electric Co.
Dayton, O.

The Adams Company
Dubuque, Ia.

The Ferguson Gear Co.
Gastonia, N. C.

Hartford Special Mchny. Co.
Hartford, Conn.

Beaty Machine Works
Keokuk, Ia.

The Generating Gear Co.
Milwaukee, Wis.

Badger State Gear Co.
Milwaukee, Wis.

Precision Machine Co.
Milwaukee, Wis.

E. A. Pynch Co.
Minneapolis, Minn.

Joaquin Alemany Lopez
Havana, Cuba

New Jersey Gear & Mfg. Co.
Newark, N. J.

Prager, Inc.
New Orleans, La.

J. Morrison Gilmour
151 Lafayette St.
New York City

Sier-Bath, Inc.
New York City, N. Y.

E. M. Smith Machine Co.
Peoria, Ill.

The Eagle Gear & Mch. Co.
Philadelphia, Pa.

Rodney Davis and Sons
Philadelphia, Pa.

The Pittsburgh Machine & Supply Co., Pittsburgh, Pa.

Standard Gear Co.
Pittsburgh, Pa.

H. W. Honeymon & Son
Providence, R. I.

Perkins Machine & Gear Co.
Springfield, Mass.

Winfield H. Smith, Inc.
Springbille, N. Y.

Alling Lander Company
Sodus, N. Y.

Charles E. Crofoot Gear Corp'n, South Easton, Mass.

Arlington Machine Co.
St. Paul, Minn.

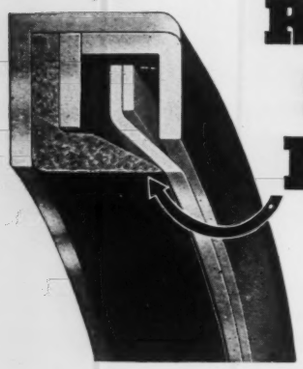
Farwell Mfg. Co.
Toledo, Ohio

Diefendorf Gear Corp.
Syracuse, N. Y.

Worcester Gear Works
Worcester, Mass.

Massachusetts Gear & Tool Co., Woburn, Mass.

FORMICA NON-METALLIC GEARS



Reduces Shaft Friction

The tapered edge of the leather washer of the Gits Precision Oil Seal reduces shaft friction. Only the slightest pressure at this point forms an effective oil seal.

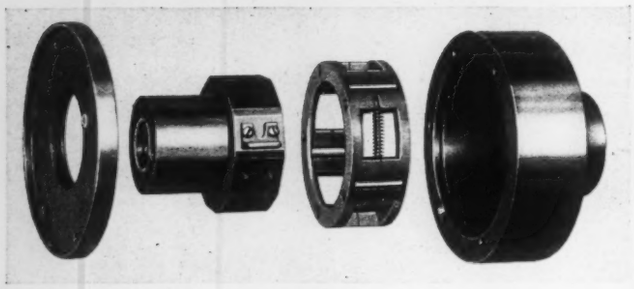
Precision Oil Seals are just that . . . they are accurately machined to very close tolerances. They are equally efficient on horizontal or vertical shafts.

A folder will be mailed at your request.

GITS BROS. MFG. CO.
1861 So. Kilbourn Ave., Chicago, Ill.

GITS Precision Oil Seal

free-wheeling in drive design



HILLIARD OVER-RUNNING CLUTCHES

COMPLICATED driving mechanisms attached to most modern day lay-out can now be simplified with the application of the *Hilliard Over-Running* (Free Wheeling) *Clutch* —serving as either clutch or coupling.

Particularly suitable for dual drives, two speed drives and as a ratchet having an infinite number of settings and no backlash.

Its long wearing, trouble-free life is dependent upon its extreme simplicity and the use of oil-hardened high carbon steel, ground to size, for the inner members, rollers and outer ring—shown in illustration.

Suggestions and estimates may be yours without obligation. Ask for Bulletin 103-D.

Clutches for Every Purpose

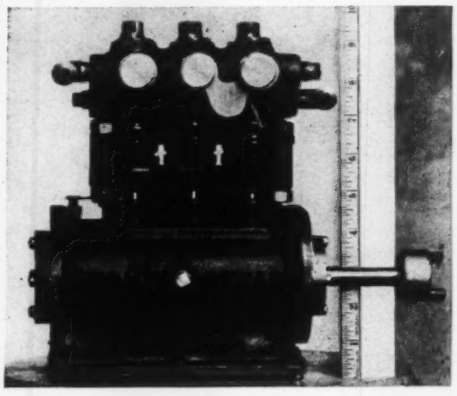
THE HILLIARD CORPORATION
ELMIRA, N. Y.

Clutch Makers for Thirty Years

(brush type) for operation on direct current. Speeds available are 1.6 to 150 RPM. Standard voltage is 110, but the motor is available for special voltages.

Small Pump Is Reciprocating Type

CAPACITY of the new small positive displacement pump announced by Homestead Valve Mfg. Co., Coraopolis, Pa., may be varied from about 15 to 120 gallons per hour, depending upon the speed of the pump. A ¼ horsepower motor will operate the pump at 60 gallons per hour capacity and 200 pounds pressure. The



Capacity of positive displacement pump is varied by speed of the motor

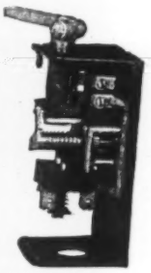
unit, shown herewith, is a single-acting plunger pump having three cylinders of ¾-inch bore and ⅝-inch stroke with the plungers attached to crosshead guides which are driven by connecting rods from the crankshaft.

Pure water, water containing various percentages of alkaline compounds, fuel oils, mineral oils and various chemicals are most readily handled by this pump. It is adaptable to a variety of uses such as boiler feed, boiler compound injection, condensate returns, small hydraulic presses, fuel oil pumps for oil burners, pumping of chemical, air conditioning apparatus and control apparatus.

Develops New Master Switches

MASTER switches of the shipper-rod-operated type, which perform the function of a two-button momentary contact pushbutton station, have been brought out by General Electric Co., Schenectady, N. Y. The switch, shown herewith, possesses advantages over previous switches of this type in that its magnetic contactor will pick-up and seal-in even when the shipper rod is operated rapidly. The contactor will drop out and remain unenergized in the case

of voltage failure even when the shipper rod does not complete its travel. A short time delay between making and breaking the pick-up circuit is employed so that this circuit will al-

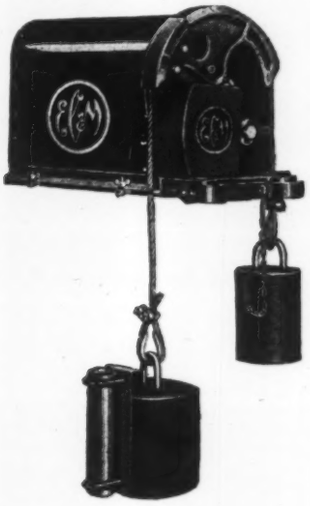


Performing the functions of a two-button momentary contact push-button station, master switches are of the shipper-rod-operated type

ways be broken after it has once been established, regardless of the position in which the shipper rod is left.

New Controls Insure Safety

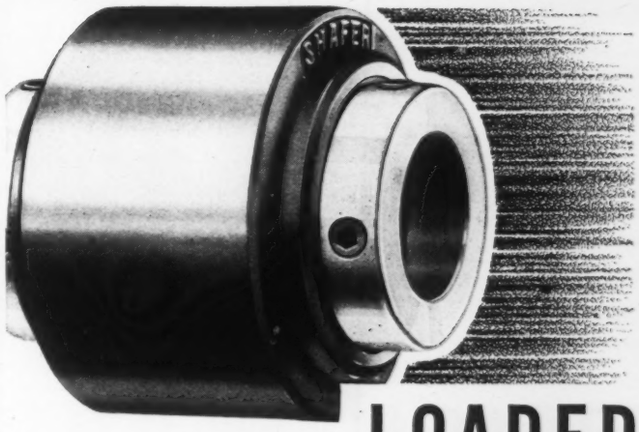
FOR use as a safety device in preventing overhoisting accidents on overhead traveling cranes and other applications where positive protection against overtravel is essential, Electric Controller & Mfg. Co., 2733 East Seventy-ninth street, Cleveland, has announced an improved Youngstown safety limit stop. This limit stop is of the main motor circuit type, handling



Limit stop is intended for use as a safety device in preventing overhoisting accidents and similar mishaps

motor currents directly without the aid of additional equipment. When the limit stop is tripped, it not only disconnects the motor from the power line but it also brings the motor to rest quickly with minimum drift.

The improvement in this limit stop consists of the use of needle-type roller bearings to provide almost frictionless operation, elimination of bearing wear, and infrequent lubrication, and



LOADED
with Bearing Performance

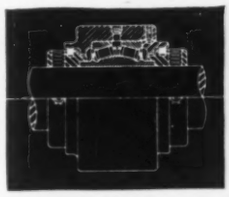
SHAFER CARTRIDGE UNITS provide a simple unit-application of generous radial-thrust roller bearing capacity, in which the shaft may be removed without disturbing the bearing assembly.

The exclusive Shafer CONCAVE roller design combines—1. Generous roller bearing capacity for any combination of radial-thrust loads, 2. Natural, free-rolling self-alignment within the bearing itself, 3. Simple adjustability.

Convenient installation, *extra* anti-friction performance, and assured long life with minimum maintenance are easily obtained. Specify Shafer Self-aligning Roller Bearings.

Available in a full range of sizes: Cartridge Units • Pillow Blocks • Hanger Boxes • Flange Units • Take-up Units • Duplex Units • Conveyor Rolls • Radial-thrust Roller Bearings.

Write for Catalog 12.



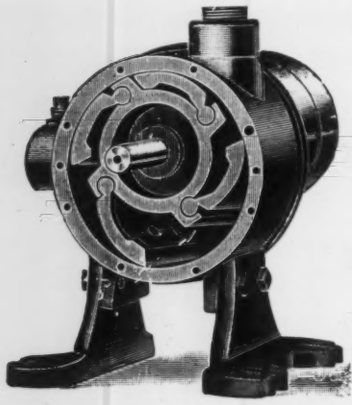
Note piston ring seal and double-end square □ drive collars.

SHAFER BEARING CORPORATION
6513 West Grand Avenue, Chicago, Ill.

SHAFER
roller bearing
CARTRIDGE UNITS

THE MACHINE DESIGNERS' FAVORITE AIR PUMP

Favorite because of its numerous sizes, its simple lines of construction, but above all because of its reliability —its positive performance which—just because it is so simple in design—can never fail to give its best.



LEIMAN BROS.
Patented Rotary Positive
AIR PUMPS
for pressure, vacuum and gas pumping

They Take Up Their Own Wear

Used on all worth-while automatic machines, paper feeders, bottle fillers, oil burners, and gas appliances.

Aerating — Agitating — Singeing — Branding — Preheating — Assaying — Brazing — Annealing — Soldering — Forging — Calliopes — Milking Machines — Steam Heating Systems — Paper Feeding Devices — Printing Presses — Oil Furnaces — Gas Furnaces — Coal Furnaces — Suction Chucks — Vacuum Cleaning — Solder Iron Heaters — Wrapping Machines — Mailing Machines — Testing Gas Fittings — Removing Foul Air — Supplying Fresh Air — Melting — Hardening — Massaging Machines — Laboratory Work — Blow Lamps — Blow Pipes — Glass Blowing — Gas Pumping — Testing Meters — Pressing Irons — Vacuum Frames

LEIMAN BROS., INC.

177 (2) Christie St., Newark, N. J.
LEIMAN BROS. N. Y. CORP. 23 (P2) Walker St., New York, N. Y.
Makers of Good Machinery for 45 Years

Write for it . . .

● YOUR SAMPLE FILE of the standard types of felt—bound into a chart classifying applications of each type! Designed to be useful to all users of felt—not for sales follow-up. Mailed without charge.

Booth
PRECISION CUT FELT

BOOTH FELT COMPANY, INC. 444—19TH ST., BROOKLYN, N. Y.

the use of a new heavier gage gasketed cover which is bolted down tightly against shoulders now supplied on the enclosing case, providing a splashproof and dustproof design and rigid, injury-resisting construction.

Plastic Material Withstands Friction

TO WITHSTAND the action in those parts where constant friction plus impacts of varying degrees, requires material of greater resistance than that usually supplied, General Plastics Inc., North Tonawanda, N. Y., has developed a new material known as Durez 1564 which combines both impact strength and friction resistance. This material contains 10 per cent graphite and has an impact strength of roughly 40 per cent greater. Its uses include machine parts in constant friction, refrigerator latch bolts, cam parts, automobile door bumper shoes, etc.

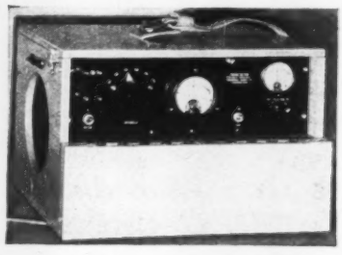
Connectors Easily Disassembled

QUICK detachable connectors, designed for use in connecting welding or electrode cable, which lock in position and cannot work loose nor be accidentally pulled apart are being marketed by Lincoln Electric Co., Cleveland. In operating the connector the plug is inserted in the pack and a twist of the wrist locks the connection. To disconnect, the procedure is reversed. Protection against grounding is assured by fiber insulating sleeves.

Engineering Department Equipment

Noise Meter Is Improved

FOR INDUSTRIAL noise measurement and noise-level surveys, General Radio Co., 30 State street, Cambridge A., Mass., is introducing a redesign of its noise meter. This instrument



Reference level of noise meter is now the threshold of hearing for a person whose hearing is acute

differs from the earlier models in that the reference level is now the threshold of hearing for a person whose hearing is unusually acute. The

overall sensitivity has been increased to the extent of three decibels. A special dynamic noise-pickup unit which is similar in construction to the usual permanent-magnet dynamic speaker and which is considerably more sensitive and rugged than the usual microphone is employed in the unit.

New Blueprinter Is Versatile

DEVELOPED to provide continuous printing of moderate requirements, the new Model "7" printer of C. F. Pease Co., 813 Franklin street, Chicago, will reproduce tracings, charts, diagrams, bulletins, etc., in a variety of forms including blueprints, brown-prints or direct process prints in any dimensions up to 42 inches in width. Uniform illumination in the printer is provided by an arrangement of 3½-ampere fifty-inch mercury vapor tubes. Each tube is independently mounted and is connected to an auxiliary starting apparatus and reactance unit

Small blueprinter will reproduce a number of different types of forms

mounted with the machine underneath the feed table. When the machine is equipped with three tubes, sufficient illumination is produced to provide a printing speed of two linear feet per minute, and when equipped with four tubes, of two and one-half linear feet per minute using good tracings and a fast blueprint paper or direct process paper.

The printer is driven by means of a special variable speed motor and all speeds are controlled by a 28-point rheostat located at the right-hand side of the machine. Motor power is transmitted to a worm gear reduction unit by a

The new FREE Bruning sample book of tracing papers, tracing cloths and drawing papers is a veritable mine of information—a reference book well worth having. Years of scientific investigation and experience have gone into the making of the papers and cloths it contains. Here, you will find a *complete line*—the right paper or cloth, at the right price, for every purpose.

Unlike many other sample books, this book contains no "dead timber"—no useless duplications. Every sample is accurately described in terms of what it will do. Qualities of the materials shown are accurately and honestly given, without ballyhoo or excess verbiage.

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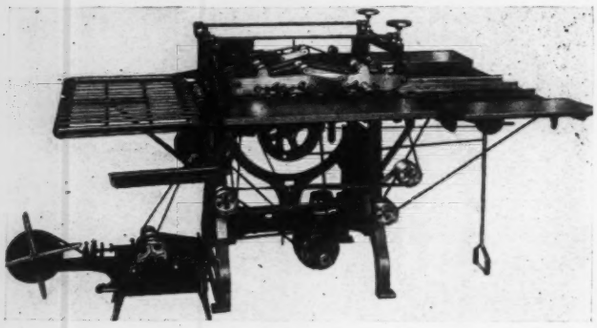
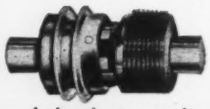
PULLMORE CLUTCHES
used in Bookbinding Machinery

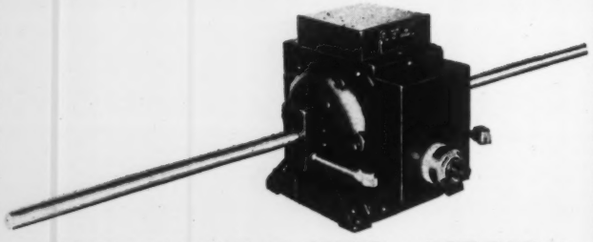




One of many different kinds of equipment in which Pullmore Clutches are used is the Stripping Machine shown above. Machines of this type are used in bookbinderies and printing plants throughout the world. With this widespread distribution, reliability and durability are at a premium. The manufacturers of this machine write "We have used Pullmore Clutches for several years and have yet to find one that we have had to replace." Pullmore Clutches are made in many sizes, single and double types, for operation in oil or dry, for transmitting up to 75 h.p. They are compact, efficient, readily adaptable to machine design. Investigate! Write today for the Pullmore Catalog.

ROCKFORD DRILLING MACHINE CO.
Division Borg-Warner Corp.
304 Catherine Street, Rockford, Illinois
Sold by MORSE CHAIN CO., Ithaca, N. Y. Offices in principal cities

MOTORS
BUILT TO FIT THE JOB



QUIET VARYING SPEED MOTORS
FOR
AIR CONDITIONING
AND
VENTILATING SYSTEMS
WRITE DEPT. 14
HOLTZER-CABOT ELECTRIC CO.
MOTOR SPECIALISTS

special composition endless belt and the reduction unit worm wheel shaft connects to the contact band drive roll by means of cut steel sprockets and a steel roller chain. Motor pulley is a 2-step type, permitting the belt to be shifted so as to provide a higher or lower speed ratio.

Professional Viewpoints

(*Concluded from Page* 46)

diligence ought to make him a big earner, but they don't because his training is so narrow. He can't handle people (except workmen) and he doesn't have the background to get into the "outside" end of business, where the money is.

Young engineers ought to know a lot about patent law and considerable about commercial law and such things as workmen's compensation. Ignorance here can cost the firm plenty. Present law courses in engineering schools are apparently too sketchy.

Perhaps more than anything else, an engineer must be able to talk to people with two objects, to explain and to convince. His work is technical, complicated and mysterious. Yet he must convince the management that he should get what he wants—a larger appropriation, adoption of a new product, better machinery, etc. Public speaking is the answer—not oratory or declamation, but debate. A debater must make his audience understand his argument first, then believe it. And no ex-debater ever got tongue-tied before the board of directors, or confused before the general manager.

This gift merges into salesmanship, and engineers are the world's worst salesmen. From the time he decides to be an engineer, the young man ought to sell, sell, sell. Door-to-door selling is bitter medicine, but good; you learn what people want, and how to get down to business quickly.

Finally, the engineer ought to know something of the "business sciences"—administration, advertising, finance, banking. Depreciation and taxes are not just words but factors which vitally affect engineering decisions. And the trend of the stock market or the state of the mortgage market may affect the engineering department more than the latest improvement in welding.

In a word, engineers are too deep and not broad enough. And it's a shame, for they are the best people there are. If I ever hire any more men, I want to catch some young engineering graduates before the slide-rule disease becomes chronic, and try to graft some imagination and ability to mix with people on to their splendid accuracy, thoroughness and diligence.

—A. W. MILLER,
E. C. van Dyke Inc.

Calendar of MEETINGS and EXPOSITIONS

TECHNICAL meetings of engineering societies provide a source of information that should not be neglected . . . . In most cases the authorities in various fields bring up-to-date information of vital importance to the designer . . . . Open discussion of the presentations gives the engineer an opportunity to obtain even more information * * * Further than this, these meetings enable the engineer to contact once again his contemporaries . . . . These contacts do, of course, permit the wider interchange of knowledge and are of inestimable value, both socially and professionally * * * When these meetings are held in co-operation with an exposition, the opportunities are even further enhanced . . . . The necessary interchange of ideas for continual design improvement comes from observing the works of others, talking with engineers, learning the latest developments, then taking time out at home to think it all over.

Feb. 17-21—

American Institute of Mining and Metallurgical Engineers. Annual winter meeting to be held at Engineering Societies building, New York. A. B. Parsons, 29 West Thirty-ninth street, New York, is secretary of the institute.

March 3-6—

American Management association. Annual packaging conference and exhibition of machines to be held at Hotel Pennsylvania, New York. Alvin E. Dodd, 20 Vesey street, New York, is executive vice president.

March 9-12—

National Railway Appliances association. Annual exhibition of machines and equipment and annual meeting at the Coliseum, Chicago. C. W. Kelly, 910 South Michigan avenue, Chicago, is secretary.

March 10-12—

American Railway Engineering association. Annual meeting at the Palmer House, Chicago. E. H. Fritch, 59 East Van Buren street, Chicago, is secretary.

April 14-18—

National Oil Burner Show. Annual exhibition of oil burners and equipment will be held at Convention Hall, Detroit. G. Harvey Porter, 30 Rockefeller Plaza, New York, is managing director.

April 20-25—

Oil Equipment and Engineering Exposition. Seventh annual exhibition of machinery and equipment is to be held at the Convention Hall, Houston, Texas. E. G. Linzner, P. O. Box 490 Houston, Texas, is general manager of the exposition.

• Provision must be made in the design of modern production machinery, for lubricating *all* bearings *mechanically.* When lubricating by hand, some bearings are sure to be missed: but with Farval, every bearing in the system receives the correct amount, and shutdowns for repairs are avoided.

A Farval Centralized System of Lubrication will deliver a measured charge of lubricant to all bearings from one central point, and none will be missed.

The System may be manually operated, or fully automatic; and can be supplied to deliver either oil or grease. Uninterrupted production on more than a million industrial bearings is being provided today by the positive, dependable performance of the Farval Centralized System of Lubrication.

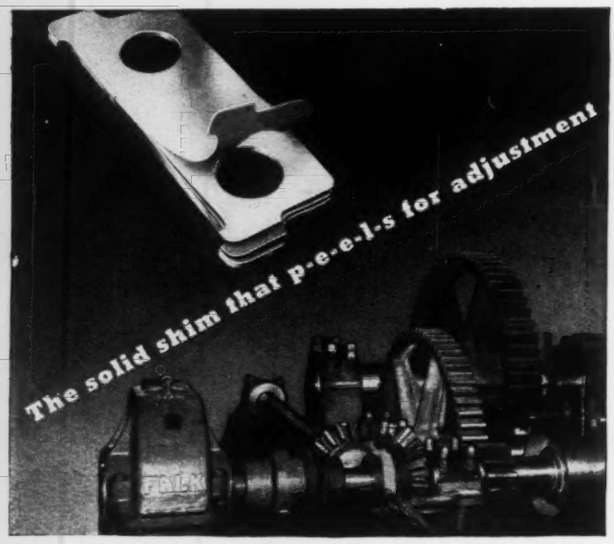
Inquiries are invited from Design Engineers. Literature showing applications of Farval Systems to principal types of machinery, will be sent on request. A Farval Engineer near you will gladly bring detailed information. The Farval Corporation, 3265 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Co., Cleveland, Manufacturers of automotive and industrial worm gearing.

FARVAL

CENTRALIZED SYSTEM OF LUBRICATION

Special Delivery to Every Bearing



1 of 4 Milwaukee Bridge Co. operating units at Ruby Street bascule bridge, Joliet, Ill.

● precision bearing adjustments

By adopting Laminum shims Milwaukee Bridge Co. provides quick, accurate service adjustment for the life of the equipment.

You simply p-e-e-l one or more .003" laminations at a time from the shim. No filing . . . no miking! Write for sample shim.

THE SOLID SHIM THAT P-E-E-L-S FOR ADJUSTMENT

LAMINUM

LAMINATED SHIM CO., INC. 2126 44th Ave., Long Island City, N.Y.

—Another

NEW

BROWN & SHARPE MOTORPUMP . . . the No. 204 REVERSIBLE CENTRIFUGAL

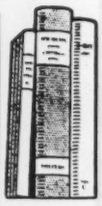
May we tell you about its many advantages?

Circular on request.

Brown & Sharpe Mfg. Co. Providence, R. I.

Brown & Sharpe Pumps

Geared — Vane — Centrifugal



MANUFACTURERS' PUBLICATIONS

ALLOYS (NICKEL)—A comprehensive and authoritative discussion of the thermal expansion characteristics of some pearlitic as well as austenitic nickel cast irons is included in section 3, No. 6 of *Nickel Cast Iron Data* sheets prepared by International Nickel Co., New York.

ALLOYS (STEEL)—In a booklet beautifully illustrated in colors, Joseph T. Ryerson & Son Inc., Chicago, presents uses of Allegheny stainless steels in many forms and for many fields. Forms include sheet, strip, wire, plate, bars, tubing, pipe and fabricated parts.

BASES—Korfund Co. Inc., Long Island City, N. Y., has prepared data sheets on its line of bases for machinery isolation and on its new Type T Seismo-Damper for use with machinery too light for installation upon natural cork plates or where the larger dampers are not warranted.

BEARINGS—Hoover Steel Ball Co., Ann Arbor, Mich., is distributing lubrication bulletin No. 6 which gives general specifications for greases and recommended greases for ball bearings. The data is presented in convenient chart form.

BEARINGS—Johnson Bronze Co., New Castle, Pa., is distributing the 1936 edition of its general catalog which lists over 600 sizes of general purpose bearings; gives complete size and weight information on completely machined bronze bars, both cored and solid; and discusses electric motor service bearings, with each bearing illustrated.

BEARINGS—Typical layouts for the application of tapered roller bearings to all types of crane machinery are presented in the crane section prepared as a supplement to the *Engineering Journal* of Timken Roller Bearing Co., Canton, O. Bearing recommendations, tolerances and fits, and other details of the design are listed in table form while cross-sectional drawings indicate preferred designs.

BEARINGS — McGill Mfg. Co., Valparaiso, Ind., is distributing bulletin No. 36 on its line of Multirol full type roller bearings. These parts are journal roller bearings fitted with small diameter rollers and are manufactured to SAE tolerances. Also covered in the bulletin are cam follower roller bearings which make use of the Multirol bearings in withstanding the intermittent shock loads usually encountered by cam followers.

DRIVES (ELECTRICAL)—A magnetic-contactor type of controller for operation of battery-operated equipment is covered by a new bulletin of General Electric Co., Schenectady, N. Y., GEA 2100.

DESIGN DEPARTMENT — Blueprinters for continuous printing of moderate requirements are discussed in a folder of C. F. Pease Co., Chicago, on its new model "7" printer which will reproduce tracings, charts, diagrams, bulletins, etc., in a variety of forms including blueprints, brown-prints or direct process prints.

DRIVES—Steam turbines for the mechanical drive of pumps, fans, compressors, blowers, pulverizers, paper ma-

chines and similar units are completely presented and pictured in bulletin GEA-1145C of General Electric Co., Schenectady, N. Y.

DRIVES—Sizes of V-belts available and a description of the belts are included in a recent bulletin of Worthington Pump & Machinery Corp., Harrison, N. J.

GEARS—John Waldron Corp., New Brunswick, N. J., has issued a new folder which discusses the company's line of silent steel gears, made up from laminations, and gives data on gear blanks for these gears which are furnished in various sizes and fixed face widths.

INSTRUMENTS—Testing laboratory equipment including spectrometers, spectroscopes, spectrographs, polariscopes, interferometers, light sources and similar precision devices are presented in catalog L-2 of Gaertner Scientific Corp., Chicago.

LUBRICATION AND LUBRICATING EQUIPMENT—Lubrication recommendations classified according to types of machinery and to types of gears and bearings are given in an *Industrial Lubrication Reference Manual* being distributed by Alemite Corp., Chicago. The publication discusses common causes of bearing failures, lubrication of antifriction bearings, grooving of bearings, gears and their lubrication, etc.

PUMPS—Motorized units for hot well service and for pumping volatile liquids against medium heads are described and illustrated in a folder of Worthington Pump & Machinery Corp., Harrison, N. J.

STEEL (ALLOY-CLAD)—All of the data accumulated over the past five years on approved methods of fabricating nickel-clad steel is included in bulletin T-4 of Lukens Steel Co., Coatesville, Pa. These fabrication methods are of especial importance to the designer considering the application of these steels as they indicate the necessary design to assure correct fabrication.

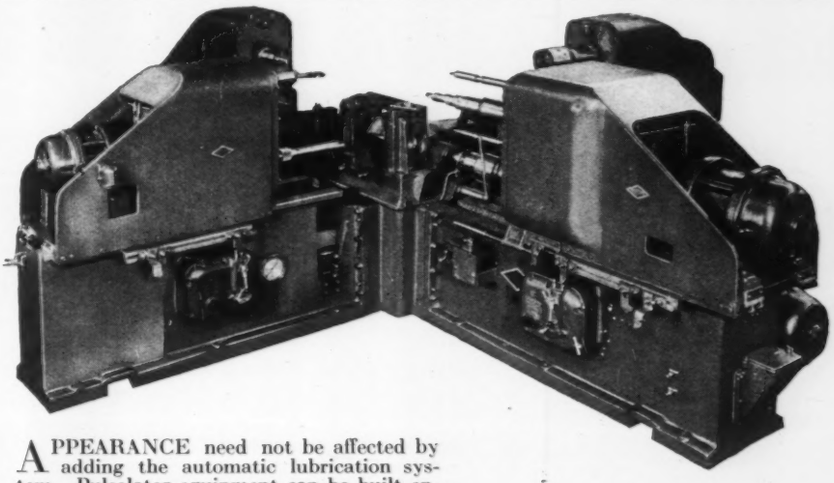
TANTALUM—How this ductile, strong and workable material can now be fabricated into process equipment as well as a wide variety of smaller devices is outlined in detail in a most complete and comprehensive 46-page booklet on tantalum published by Fansteel Metallurgical Corp., North Chicago, Ill. Applications of the material are described and illustrated, physical and chemical properties are tabulated and explained, and engineering tables give technical characteristics.

Research Publications

Determination of Stresses from Strains. When stresses in a material under load cannot be measured directly, as in a simple tensile test, for example, they may sometimes be determined indirectly by measuring strains. In the case of plane stress, such as exists in a plate subjected to forces acting in its plane, it is possible, by measuring the strains on four intersecting lines 45 degrees apart, to determine very simply the maximum and minimum stresses in the plane of stress and also their directions. Equations for these stresses and their directions are given. Published as RP851 by Government Printing Office, Washington.

Customers demand

AUTOMATIC OIL LUBRICATION



INDUSTRY now realizes that modern machine tools with their amazing refinements and high production qualities require automatic lubrication.

BLANCHARD PULSOLATOR is a centralized automatic oiling system designed to insure perfect lubrication to every bearing and to control excessive maintenance costs on modern machine tools. Our engineers can design these features into your machines by the application of PULSOLATOR.

APPEARANCE need not be affected by adding the automatic lubrication system. Pulsolator equipment can be built entirely within the machine frame and be relied upon to deliver unvarying amounts of oil to every inaccessible and hidden bearing.

"Self-cleaning" adjustable feeders, constructed to prevent dirt stoppage, are supplied either with sight glasses for gravity feed through drip tubes or for pressure feed, without sight glasses. All bearings may be instantly flushed by indicator flush lever. Send for Bulletin B-10.

PULSOLATOR AUTOMATIC OIL LUBRICATION

RIVETT LATHE & GRINDER INC.
BRIGHTON, BOSTON, MASS.

Business and Sales Briefs

PLASKON CO. INC., has been adopted as the new name of Toledo Synthetic Products Inc., manufacturer of urea formaldehyde plastics. The change in name involves no changes in personnel or management of the company. New York offices, of Plaskon Co. Inc. have been opened at 41 East Forty-second street.

* * *

Udylite Co., Detroit, has opened a Cleveland warehouse at 3756 Carnegie avenue at which point complete stocks of electroplating and polishing equipment and supplies will be carried.

* * *

Albra Castings Corp. has opened an especially-equipped modern foundry at Huntington, Ind., for the production of aluminum, brass, bronze, Monel and other nonferrous castings. Herman Voges Jr. is president of the new organization.

* * *

Torrington Co., Torrington, Conn., and its subsidiary, Bantam Ball Bearing Co., South Bend, Ind., have appointed A. S. Hellstrom as manager of the Cleveland, Youngstown, Akron and Wheeling districts, with offices in the Caxton building, Cleveland. Mr. Hellstrom will continue to handle the engineering sales of Bantam roll neck and heavy duty bearings, together with Torrington's line of smaller bearings and specialties.

* * *

Cincinnati district sales offices of Allis-Chalmers Mfg. Co., have been moved to the Chamber of Commerce building. W. G. May continues in charge as district sales manager.

* * *

S. D. Williams has been made director of sales for Timken Steel & Tube Co., Canton, O. Mr. Williams, who started with the company as metallurgical sales engineer, will have his headquarters in Canton.

* * *

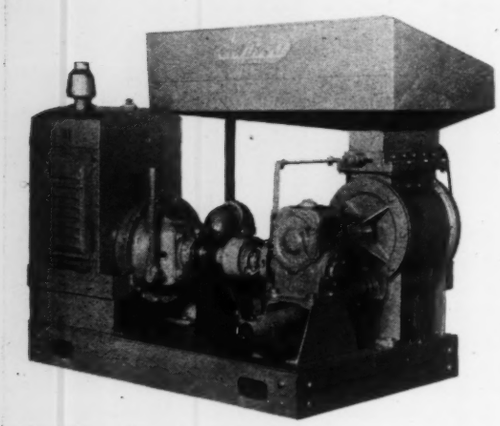
L. H. McClure has been promoted to the position of Colt-Noark sales manager for Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., manufacturer of electrical control equipment. Mr. McClure has been identified with the Colt company since 1918.

* * *

David S. Wright, formerly in the department of inspection and metallurgy of Inland Steel Co. at its Indiana Harbor, Ind., works, is now with the sales department of the company in the St. Paul, Minn., office. Mr. Wright was at one time associated with Lackawanna Steel Co. in Buffalo and Chicago.

* * *

General offices of Republic Steel Corp. have been removed to Cleveland where they will occupy floors 13 to 16 inclusive in the former Medical Arts building, recently renamed the Republic building. The move consolidates the general offices which have been located in Youngstown, the executive and Cleveland district sales offices formerly in the Union Trust building, Cleveland, and the advertising department, Mas-



IXL—5303 S. Western Ave., Chicago, Ill.

- ☐ Please have your representative call.
- ☐ Please send me literature on the items checked.
- ☐ Industrial Gears.
- ☐ Heat-treated Gears.
- ☐ Speed Reducers and Spur-Worm Helical.
- ☐ Powered Gears.
- ☐ Friction Clutches.
- ☐ Flexible Couplings.
- ☐ Special Machinery.
- ☐ Stoker Drives.

Name.....

Company.....

Address.....

IXL
THE MARK OF QUALITY

YOUR STAR SALESMAN —IXL DRIVES

THE outstanding record of performance of IXL Speed Reducers is the reason that more and more of the leading manufacturers of industrial equipment are building them into their driving mechanism.

IXL Speed Reducers, as an integral part of your machine, bring you all the advantages characteristic of the ordinary speed reducer *plus* advantages that are specifically backed by the "Mark of Quality." Behind IXL lies an experience seldom equalled. This experience goes from top to bottom. *Over 90% of IXL Employees have been building IXL Speed Reducers for over fifteen years.*

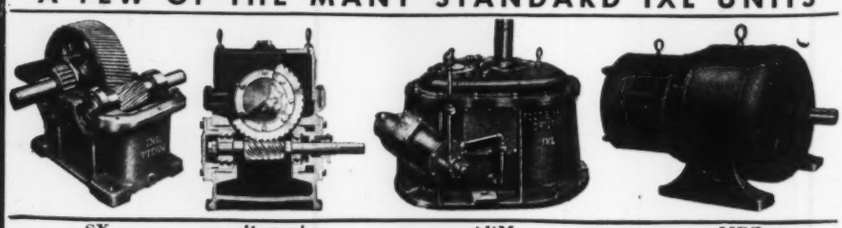
The experience necessary to your problem has already been developed. Add to this IXL "Step by Step" inspection; the type of inspection that assures precision and silent, smooth operation. These points will help you sell.

IXL Speed Reducers meet every drive condition: Vertical, horizontal or right angle drives. Built for fractional H.P. up to 250 H.P. Reduction ratios from 4 to 1 up to 10,000 to 1.

We invite you to put any speed reducers, (or gear problem) up to our engineering department. Their broad experience can be very helpful to you.

FOOTE BROS. GEAR & MACHINE CO.
5303 S. Western Blvd., Chicago, Ill.

A FEW OF THE MANY STANDARD IXL UNITS



SX *Helical Reducer* — *Hygrade Worm Reducer* — ADM *Heavy duty agitator drive* — MDZ *Helical powered gear*

sillon, O. Sales offices of Newton Steel Co. will also be located in the Republic building.

* * *

Thomas N. Armstrong Jr. has been added to the development and research staff of International Nickel Co. Inc. Mr. Armstrong, who will handle steel castings development, is in the New York office at 67 Wall street.

* * *

Allen-Bradley Co., Milwaukee, manufacturer of electric motor control equipment, has appointed S. A. Rhodes, 2015 Main street, Cromwell, Conn., as its representative in the Connecticut territory, replacing R. B. Soderberg of Hartford. The Grand Rapids, Mich., office of the company has been moved to 410 Houseman building.

CROSS SECTIONS

IMPROVEMENTS made in the technique of the electrodeposition of tin now make it possible to deposit tin alloyed with other metals to produce a harder coating which is resistant to abrasion as well as corrosion.

DESIGN is so universal that it seems strange that one man can change the entire course of events. Such influence has been exerted often in the past and is being exerted in many cases today. The fiftieth anniversary of the company he founded reminds one that George Westinghouse, opposing the great Edison, is almost wholly responsible for the present near-universal use of alternating current.

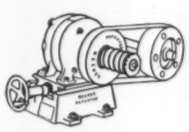
NONFERROUS foundries are decidedly in the vanguard of the foundry trade in the return to normal. This indication of a trend should suggest to designers that they might check into the question and find out if they are making as wide a use of these materials as would be advisable.

WHAT good are machines that can manufacture to 1/10,000-inch tolerances without adequate inspection? And even with our most accurate testing instruments, how can we eliminate the human element? Ford designers have solved the problem by creating a machine which spots an undesirable ten-thousandth, or lack of it, a block away, and promptly shunts disgraced camshafts to one side.

WITHIN a few weeks MACHINE DESIGN will present the latest and most accurate edition of the directory on ferrous, nonferrous and nonmetallic materials. Although we believe that we have cataloged all of the materials in active use by designers, we are checking every possible source in an effort to uncover additional materials. If you know of one which we may not have listed, please send it along and we'll add it to our ever increasing list.

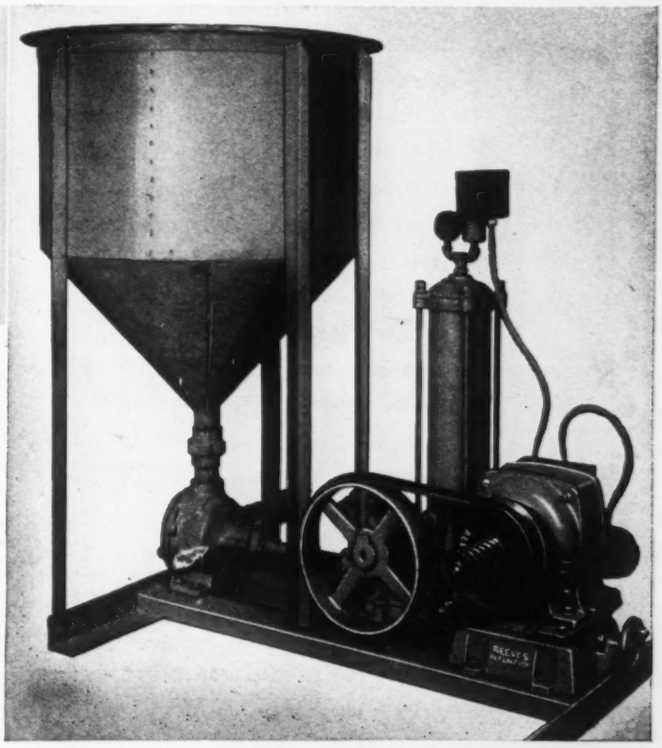
NO COMPANY has any certainty of cornering a market, nor can any one type of equipment be assured of continuous use, as long as designers keep developments humming. For example, an automatic electric door opener which will open any type of hinge door, by means of an induction arrangement, without the use of electric eyes or photocells, has been developed.

REEVES
Vari-Speed Motor Pulley
Compact, Efficient Speed Control Unit for Direct Application to Standard Motor Shaft Extension



MACHINE designers like the adaptability of the REEVES Vari-Speed Motor Pulley. . . . This simplified speed control unit may frequently be enclosed inside the frame of the machine it regulates. Handwheel control may be extended to any convenient position. Use either flat face or sheave pulley on driven shaft. To builders of light h. p. machines, requiring not more than 3:1 ratio of speed variation, the REEVES Vari-Speed Motor Pulley offers may important advantages. Provides any desired speed instantly, smoothly without stopping driven machine. Furnished in seven sizes—fractional to 7½ h. p.

***At right*—REEVES Vari-Speed Motor Pulley incorporated as standard equipment on pump which is used for spraying heavy materials such as asphalt composition. Speed may be varied to accommodate either one or two spray guns and to control pressure.**



REEVES PULLEY COMPANY, COLUMBUS, INDIANA

Send information on REEVES Vari-Speed Motor Pulley, as contained in Catalog H-36. (2-36)

Name.....

Company.....

Address.....